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EDITOR

Major William D. McDowell

CONTRIBUTORS

Lieutenant Colonel Charles R. Meyer, *Infantry*
Lieutenant Colonel Elmer Schmierer, *Infantry*
Major Irwin A. Edwards, *Infantry*
Major Virgil V. Laughlin, *Infantry*
Major Elvy B. Roberts, *Infantry*
Major Weldon E. Laiche, *Infantry*
Major William D. Wise, Jr., *Infantry*
Captain George E. Wear, *Infantry*

Original art work by Private First Class Alfred M. Russo

DIRECTOR OF PRINTING
Lieutenant Colonel Albert C. Haley

CIRCULATION MANAGER
Major Andrew W. Petrosky

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Target-Grid Method of Fire Adjustment

Using the target-grid method of adjustment, anyone who has a means of communication with either an infantry or artillery fire direction center and who can read an azimuth, can adjust fire on any target he can see. From the observer's viewpoint, the method is much simpler than previous methods because he doesn't have to know the location of the guns and he doesn't have to compute any data. It makes no difference how far he is off the gun-target line because the fire direction center makes adjustments to keep the bursts on the observer-target line. In order to get fire on the target the observer follows three simple steps:

First, establishes communication with a fire direction center.

Second, reports the correct azimuth from his position to the target and the change in range and deflection *as he sees it* from the base point (or any point known to both observer and fire direction center) to the target.

Third, continues to report the relation of the target to each burst until the mission is accomplished.

In brief, the observer merely reports what he sees; the fire direction center makes all of the computations.

Before going into the mechanics of adjusting indirect fire by the target-grid method, let us look at the fundamental picture. It will give a better understanding of what actually takes place at the fire direction center. Assume that a platoon of 4.2-inch mortars has been adjusted on a base point whose azimuth from the guns is 200 mils (Figure 1). The fire direction center has this information plotted to scale on the observed fire chart.

An observer calls fire direction center and reports that he has a fire mission. FDC does not know where the observer is but his location is not essential. The only information they need from him in order to locate the observer-target line, is his azimuth to the target and the location of

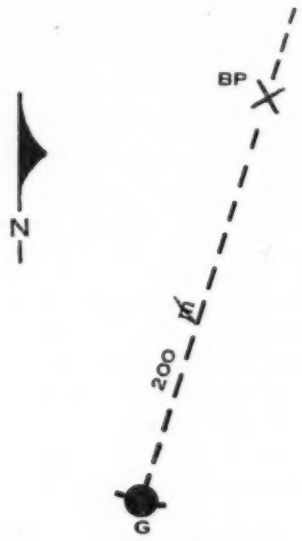


Figure 1.

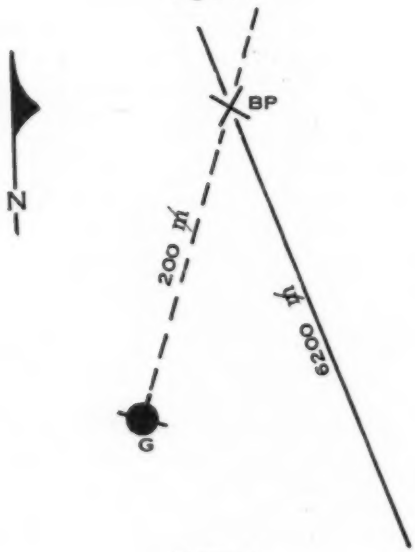


Figure 2.

the target *as he sees it* with respect to the base point. If the observer reads his initial azimuth to the target within 300 mils, the adjustment can be made in the minimum time. However, *even if the observer errs more than 300 mils, the computer can determine the true observer-target azimuth.* The observer sends back the following fire request:

OP NUMBER ONE
FIRE MISSION
AZIMUTH SIX TWO HUNDRED
FROM BASE POINT
RIGHT FOUR HUNDRED
DROP THREE HUNDRED
MACHINE GUN
WILL ADJUST

Remember that the observer's azimuth of 6200 mils is his azimuth to the target and not the azimuth to the base point; however, by drawing a line through the base point on an azimuth of 6200 mils, fire direction center can construct the observer-target line (Figure 2). The computer draws a line through the base point perpendicular to the 6200-mil line drawn through the base point. He then plots a point along this perpendicular 400 yards to the right of the base point. A line through this new point and parallel to the 6200-mil line drawn through the base point is the observer-target line (Figure 3). Fire direction center does not know where the observer is located along this line. but it does not make any difference because the observer makes his deflection correction in yards. Since the observer made his target designation as if the mortars were mounted in rear of his OP, the computer measures 300 yards along the observer-target line (toward the observer since he said drop 300) and plots the target (Figure 3).

This location of the target is an approximation since the distances from the base point are estimated. However, with this sketch it is possible to determine graphically the direction and range of the gun-target line. With a protractor the computer can determine the mil shift that should be made from base point, and he can determine the range by measuring the length of the line and applying the scale of the chart.

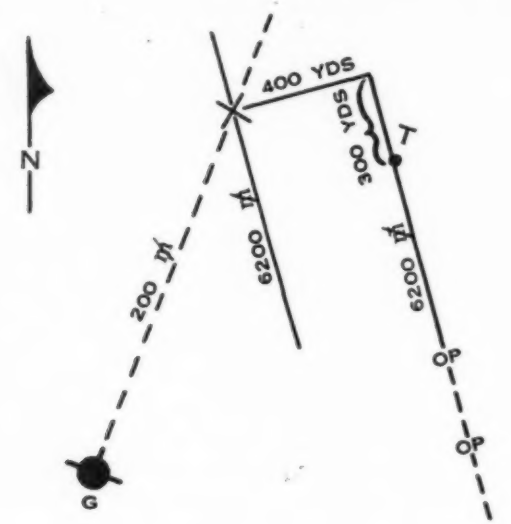


Figure 3.

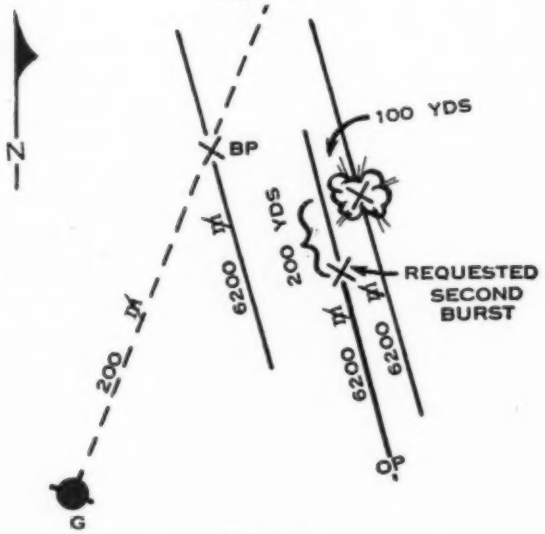


Figure 4.

Using the direction and distance obtained from the sketch, a round is fired. It will land at the plotted location of the target. If the target has been accurately located this round will hit the target; if not, the observer makes a correction to move the burst to the observer-target line and, if he has obtained a range sensing, he gives a range change large enough to establish a bracket on the target. Assume that the observer's correction is:

LEFT ONE HUNDRED
DROP TWO HUNDRED

The computer at the fire direction center can now plot the requested second round on the sketch (Figure 4). What actually happened was that the observer's initial target location was incorrect; however, it is now possible to draw in a more accurate observer-target line. Instead of a line 400 yards to the right of the base point, it is a line 300 yards to the right of the base point. With this line as a reference, correction for each burst can be plotted and the deflection and range for each burst can be graphically determined.

These simple sketches illustrate the basis of the target-grid method of adjusting fire. The method is applicable to adjustment of observed fire by any indirect fire weapon. The primary value of the method lies in its simplicity.

In adjusting the fire of a platoon of 4.2-inch mortars, (which will be used as the firing weapons throughout this article) several fire control instruments are necessary. The observer must have a pair of binoculars, a compass, and either telephone or radio communication with the fire direction center. The computers at the fire direction center must have an M-10 Plotting Board and appropriate firing tables. The horizontal control operator at the fire direction center must have the necessary maps and firing charts to determine initial directions of fire and to record each registration. The fire direction center is also equipped with telephone and radio communication to each observer and to each firing unit. The gunners need only their standard sights and aiming stakes.

M-10 PLOTTING BOARD

The actual computation of fire data is done on the M-10 Plotting Board. It consists of a rotatable, pivoted disk of transparent plastic material attached to a flat base (Figure 5). The rotatable disk is graduated around the outer edge in mils. The smallest graduations are 10 mils apart and the

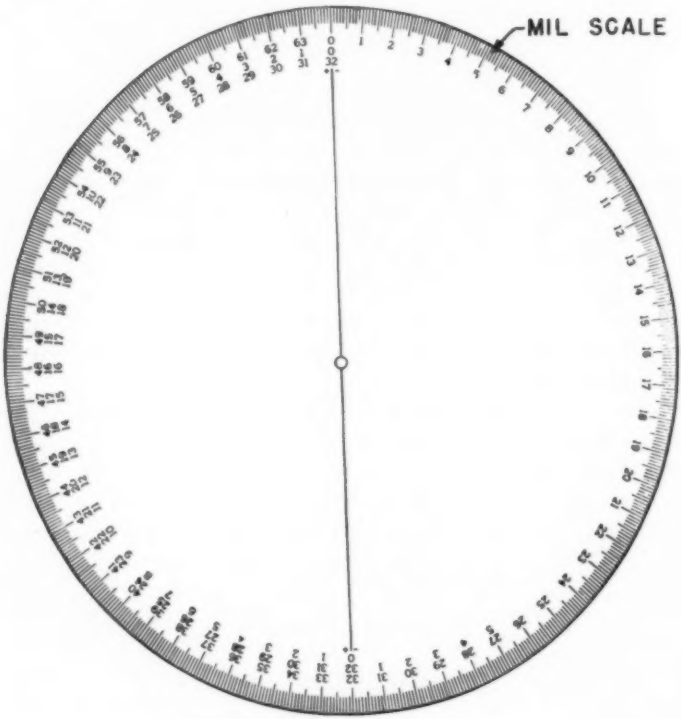


Figure 5.

graduations are numbered in a clockwise direction at each 100 mils from 0 to 63. Two inner mil scales assist the operator in reading back azimuths and angles of site. A line extends across the disk from 0 to 32 on the outside scale and passes through the pivot point.

The flat base is gridded to represent ranges or distances on the ground (Figure 6). Heavy lines extend vertically and horizontally across the base forming squares of approximately one inch. These squares are in turn divided into 100

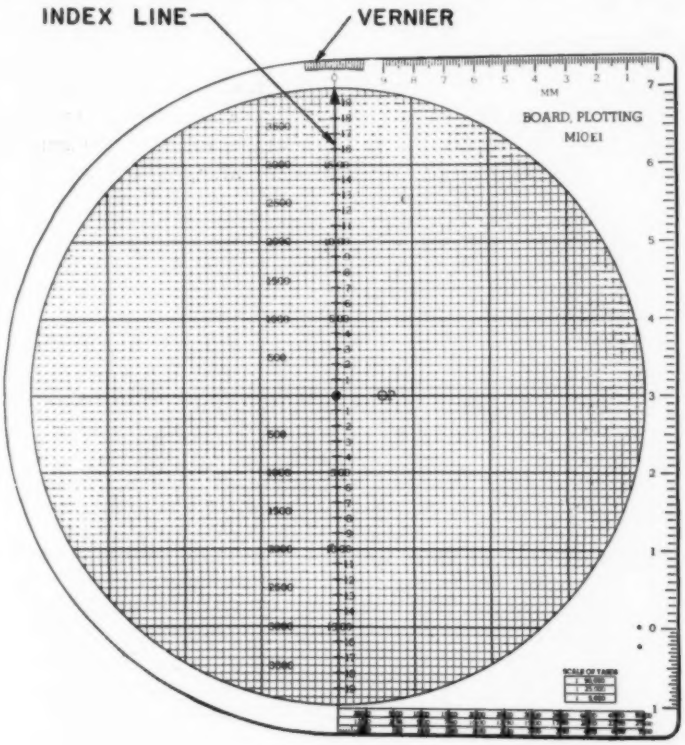


Figure 6.

small squares by thin lines running parallel to both the heavy vertical and horizontal lines. An arrow running along one of the heavy grid lines and through the pivot point is the index line on the gridded base. The arrow points to a 0 and a thin line which extends to the edge of the plotting board. This thin line is the index on the base at which all deflections or azimuths are read. The base is properly

oriented when the 0 on the base is at the top and the flat side is to the operator's right. The numbers on the gridded base mark ranges in yards at different scales.

To illustrate the operation of the plotting board, assume that the computer wants to plot a point on an azimuth of 6400 mils and at a range of 1000 yards from the gun position. (See Figure 7.) To plot this point he first plots the gun position at the center of the plotting board (marked OP on the gridded base). He then rotates the plastic disc until 6400 mils (same as 0 mils) is at the index at the top of the board. Then using the range scale along the index line,

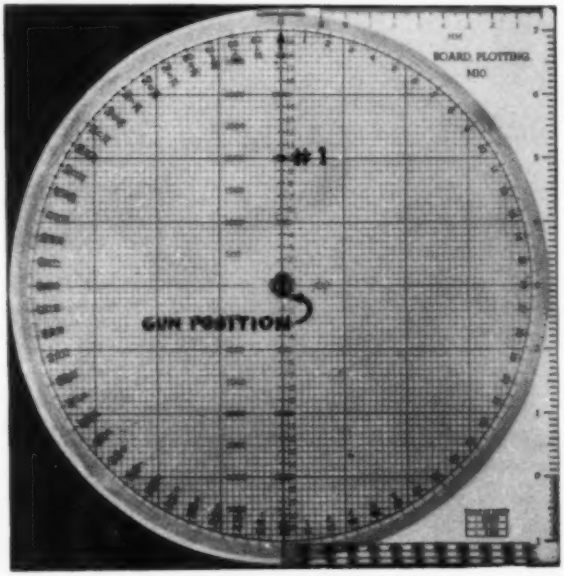


Figure 7.

he measures up 1000 yards from the gun position and at that spot plots point number 1.

Any point can be plotted on the board with relation to another point. The mil value of the angle formed by lines drawn from the gun position (center of board) to any two

points is determined by computing the difference in azimuth of the two lines. The azimuth of a line connecting any two points on the plotting board is determined by rotating the circular disk until both points lie along one of the vertical lines on the gridded base or until they are parallel to the same vertical line. When this condition exists, the azimuth is read at the index directly over the red arrow.

In order to illustrate adjustment of fire by the target grid method, assume that the 1st Platoon of a 4.2-inch morar company has just gone into position in a new location and the guns have been mounted on a *grid azimuth* of 1200 mils. This azimuth was designated by the gunnery officer at the fire direction center and was taken from a map of the area. It points the four mortars toward a sector of enemy held territory which may logically contain suitable targets for the platoon.

The gunnery officer directs the platoon sergeant to use a referred deflection of zero. That is, after the guns are laid on a grid azimuth of 1200 mils, the sights are reset at zero. (With a referred deflection of zero, the aiming stakes are directly in front of the mortars.) The computer for the 1st Platoon records the referred deflection on his plotting board by placing a zero just below 12 on the disk. He then places numbers to the left and to the right from 0 to correspond to the deflection scale on the 4.2-inch mortar sight. The numbers to the right of zero start with 3100 because the 4.2-inch mortar sight covers an arc of 3200 mils rather than a circle of 6400 mils. In this problem for example, a sight setting of 3100 mils actually means that the mortars are pointed on a grid azimuth of 1300 mils. (See Figure 8.) The computer announces all deflection changes in referred deflection rather than grid deflection.

BASE POINT ADJUSTMENT

The platoon having been mounted and laid on a grid azimuth of 1200 mils, and the sights having been reset at zero, the gunnery officer at the fire direction center contacts an observer who can observe the 1st Platoon sector and asks him to adjust the platoon on a base point. In this case the

base point is designated by the gunnery officer and pointed out to the observer by giving map coordinates and a description of the object.

When the observer definitely locates the designated base point, he reports its azimuth from his position as 900 mils. (Remember that in this problem the base point is the target. The plot of the first round will be the only point known by both the computer and the observer.) Using his map, the gunnery officer computes the range and azimuth of the first round. He then gives the computer for the 1st Platoon

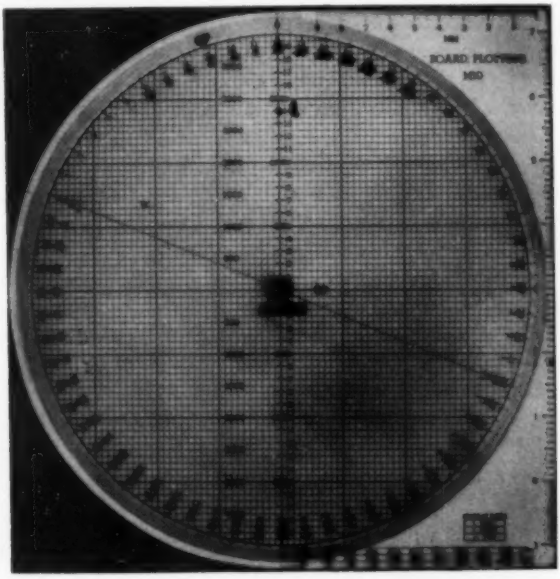


Figure 8.

the following information and directs him to complete the adjustment:

Azimuth observer-target	900 mils
Azimuth for the first round	1200 mils
The sight reading	deflection zero
Range	1400 yards

The computer places an OP symbol on the plotting board at 900 mils (grid azimuth) in order to remember the azimuth at which the observer sees the target. He then orients the plotting board at 1200 mils (referred deflection zero) and places point 1 on the 1400-yard grid on the index line. This is the point where the first round will be fired (Figure 8). He then sends the following command to the platoon:

FIRST PLATOON
SMOKE
DEFLECTION ZERO
NUMBER TWO
ONE ROUND
ELEVATION NINE HUNDRED, CHARGE SEVEN (1400 yds)
FIRE

NOTE: For problem purposes, all computations are made following the constant elevation rule and no corrections are made for the drift caused by the rotation of the shell.

All gunners place this data on their sights, lay on their aiming stakes, and mortar number 2 fires one round. The platoon reports to the fire direction center:

ON THE WAY

The computer tells the observer:

FIRST PLATOON
NUMBER TWO ADJUSTING
SMOKE
BASE POINT REGISTRATION
ONE ROUND
ON THE WAY

The observer sees the burst of the smoke shell, senses it, and sends the following correction to the fire direction center:

RIGHT TWO HUNDRED
REPEAT RANGE

The computer orients the plotting board at 900 mils, (This is done for ease of plotting because the vertical lines on the plotting board will be on an azimuth of 900 mils and parallel to the observer-target line.) plots point 2 two hundred yards to the right of point 1 (Figure 9),

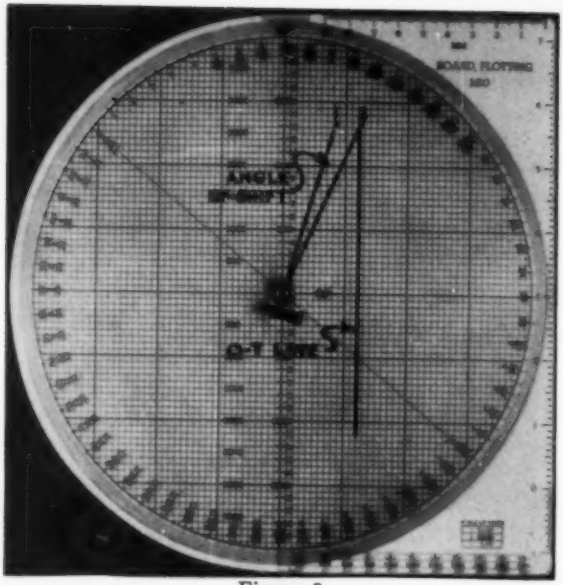


Figure 9.

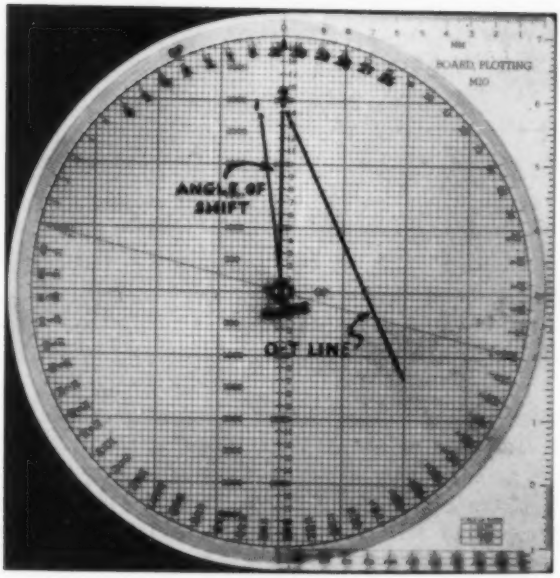


Figure 10.

orients the board so that point 2 is on the index line (Figure 10) and reads the new range and deflection from the board. He then gives the following command to the platoon:

HE
DEFLECTION THREE ZERO SIX THREE
ELEVATION EIGHT SEVEN FIVE,
CHARGE SEVEN (1465 yds)
FIRE

The deflection is read at the index of the plotting board using the referred deflection scale, and the range is determined by the scale along the index line on the gridded base.

The observer is notified that an HE round is on the way. He senses the burst and sends back the following correction:

DROP TWO HUNDRED

The computer orients the plotting board at 900 mils and plots point 3 two hundred yards below point 2 (Figure 11). (If there had been a deflection change, the computer would have known that the observer's initial correction was erroneous and would have replotted the O-T line.) He orients the board with point 3 on the index line (Figure 12) and computes the following command:

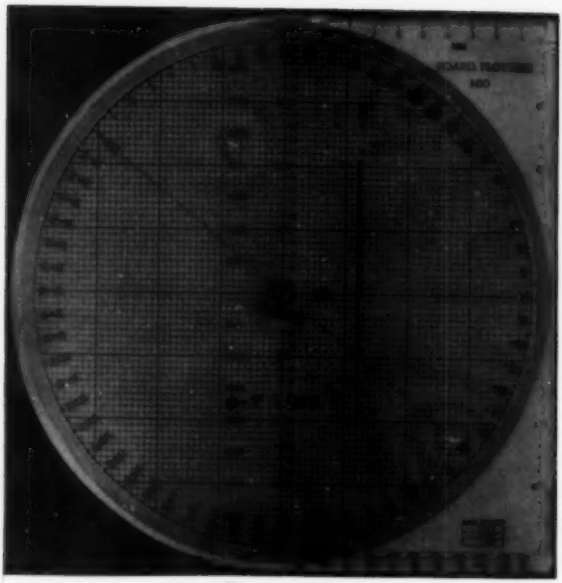
DEFLECTION TWO NINE NINE SIX
ELEVATION NINE HUNDRED, CHARGE
SIX AND ONE HALF (1300 yds)
FIRE

The observer's correction for burst 3 is:

ADD ONE HUNDRED

The computer again orients the board at 900 mils and plots point 4 (Figure 13) one hundred yards above point 3. He then orients the plotting board with point 4 over the index line (Figure 14) and computes the following command:

DEFLECTION THREE ZERO THREE
TWO
ELEVATION NINE ONE FIVE, CHARGE
SEVEN (1385 yards)
FIRE



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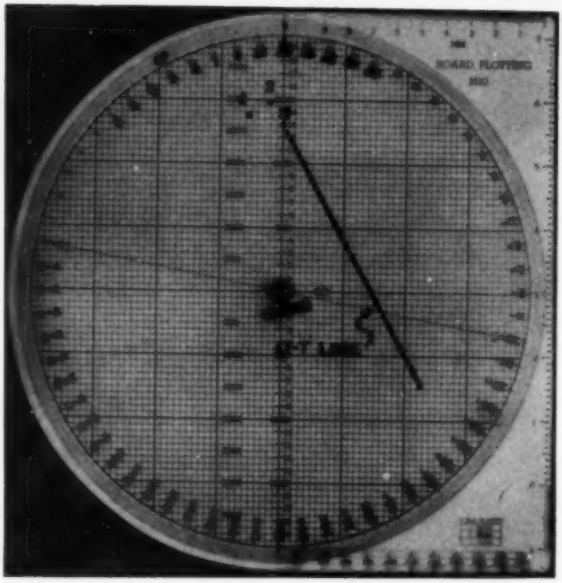

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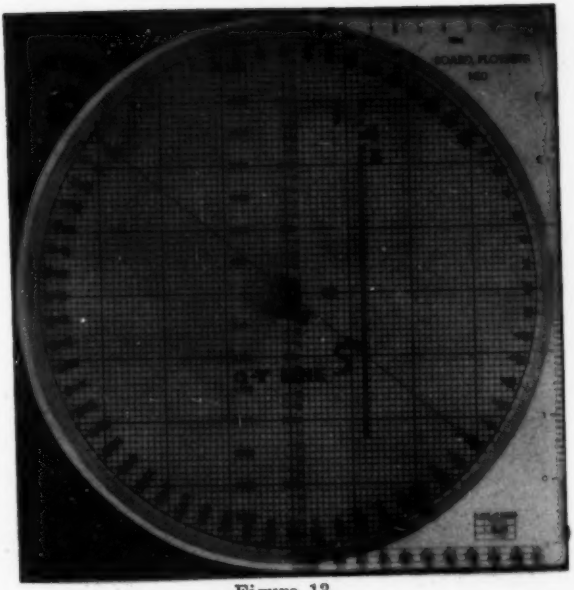

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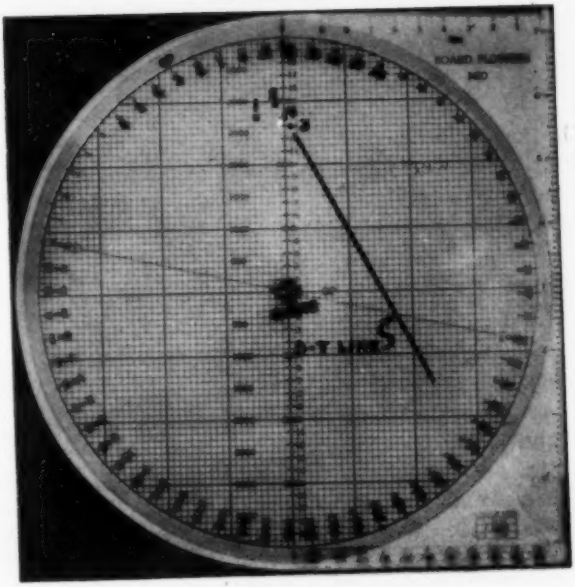


Figure 14.

The observer senses the burst and sends back the correction:

RIGHT TWO FIVE
DROP FIVE ZERO

Again, the computer orients the plotting board at 900 mils and plots point 5 twenty-five yards right and fifty yards below point 4 (Figure 15). He places point 5 over the index line (Figure 16) and computes the following command:

DEFLECTION THREE ZERO ZERO TWO
ELEVATION NINE HUNDRED, CHARGE SIX AND THREE QUARTERS (1375 yds)
FIRE

The observer senses burst 5 and sends back the following correction:

ADD TWO FIVE
ADJUSTMENT COMPLETE

The computer orients the plotting board on 900 mils and plots point 6 twenty-five yards above point 5 (Figure 17). He then places point 6 over the index line (Figure 18) and computes the following data for the base point:

DEFLECTION THREE ZERO ZERO NINE
RANGE ONE THREE SEVEN FIVE

The computer then notifies the 1st Platoon that the adjustment is complete. He labels the point at the adjusted deflection and range as BP (base point) and erases all other lines and points used during the adjustment. The adjusted deflection and range is given to the horizontal control operator who plots it on his observed fire chart. It is now possible to shift the fire of this platoon from the base point to any target in its sector of fire.

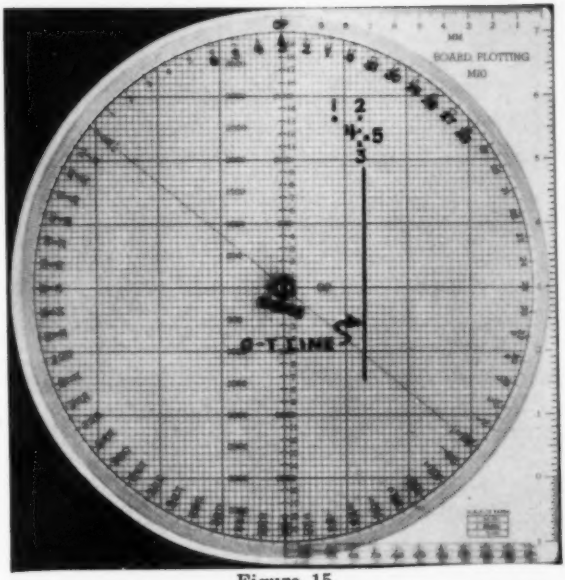


Figure 15.

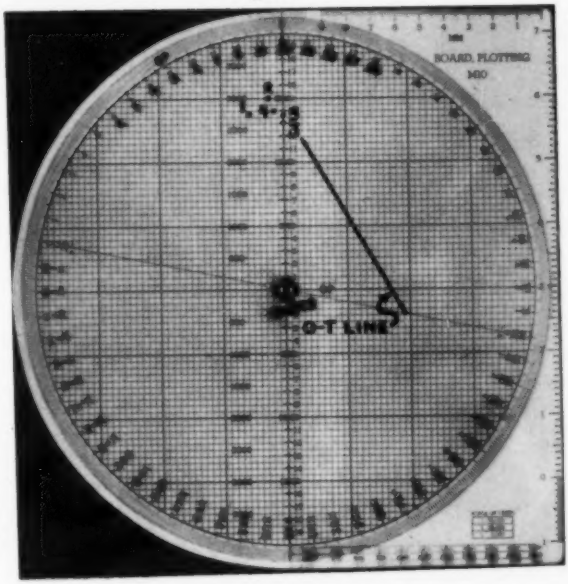


Figure 16.

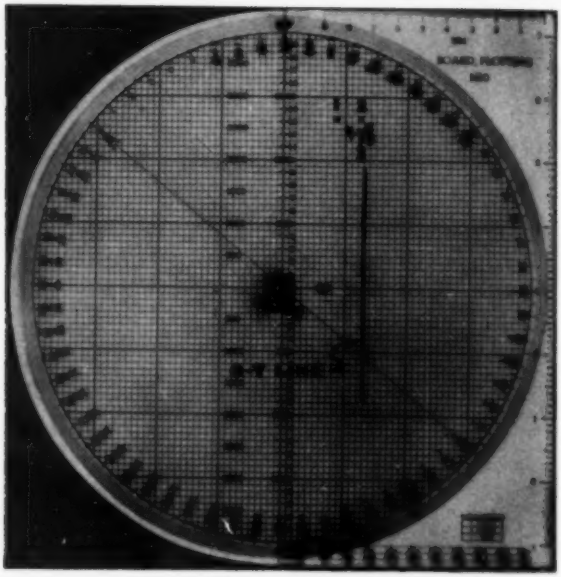


Figure 17.

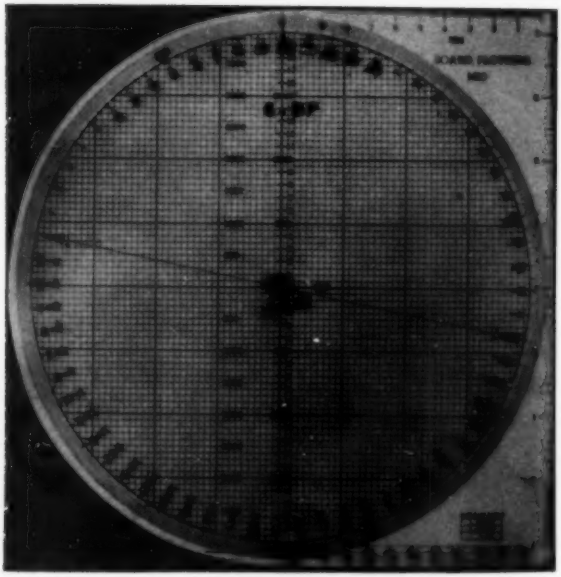


Figure 18.

TARGET ADJUSTMENT BY A PLATOON LEADER

To illustrate the simplicity of the target-grid method of adjustment, assume that a rifle platoon leader wants to initiate a fire mission.

The platoon leader first establishes radio communication with the regimental fire direction center. He tells the radio operator at FDC that he has located an enemy machine gun but there is no mortar observer available to adjust fire on the target.

Fire direction center tells the platoon leader that the 1st Platoon will fire the mission and asks him to watch the terrain to his front and they will mark the base point with a round of smoke (same base point as plotted in Figure 18). The radio operator announces ON THE WAY when the smoke round is fired and the platooon leader notes where the smoke round falls.

Next, the platoon leader carefully reads the azimuth from his position to the target. He then gives the following fire message:

FIRE MISSION
AZIMUTH THREE HUNDRED
FROM BASE POINT
LEFT FOUR HUNDRED
DROP ONE FIVE ZERO
ENEMY MACHINE GUN
WILL ADJUST

(If the platoon leader does not know the correct sequence and terminology for fire commands, the radio operator asks questions to get the necessary information.)

The radio operator relays this information to the computer. The computer writes OP above the 300-mil graduation to note the observer's azimuth to the target. (Note that the OP symbol is placed above the 300-mil graduation on the disk, not above the referred deflection 300-mil mark.) He then rotates the disc until the board is oriented at 300-mils. He draws a line through the base point on a 300-mil azimuth (a line parallel to any vertical line) and measures

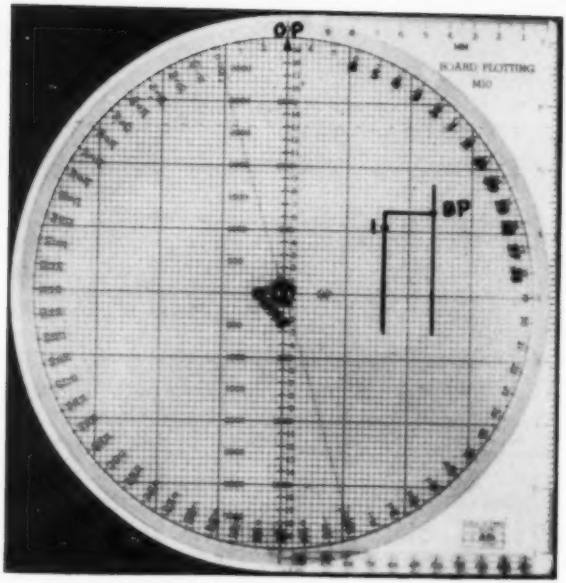


Figure 19.

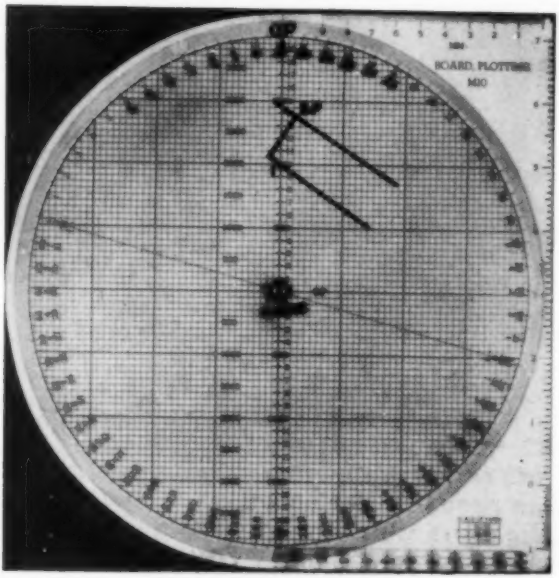


Figure 20.

400 yards (eight of the small grid squares) to the left and 150 yards (three small grid squares) toward the guns and plots point 1. (See Figure 19.)

The computer then rotates the disc until point 1 is located directly over the index line. He then reads the range and deflection for the first round—deflection 3088, range 950—and sends a fire command to the guns. (See Figure 20.)

The observer notes where the first round falls and makes the following correction:

RIGHT ONE HUNDRED
ADD ONE HUNDRED

Note that the observer merely makes a change in yards of deflection and range. He makes no effort to locate the guns or to compute factors.

When this command is relayed to the computer, he again orients the plotting board on 300 mils, and plots point 2, 100 yards to the right of and 100 yards above point 1. (See Figure 21.)

He orients point 2 over the index, reads the deflection and range and computes the fire command for the second round. (See Figure 22.)

This procedure is continued until the rifle platoon leader reports that the mission is accomplished.

SUMMARY

Tests made at the artillery and infantry schools indicate that this method of adjustment has the following advantages:

1. It requires a minimum amount of ammunition.

2. It minimizes errors and inaccuracies in the computation of fire data.

3. It minimizes errors at the guns because the computer gives the new deflection after each sensing rather than a change from the previous setting.

4. It simplifies the work of the observer and places the burden of computation on personnel of the fire direction center who can usually work under better conditions.

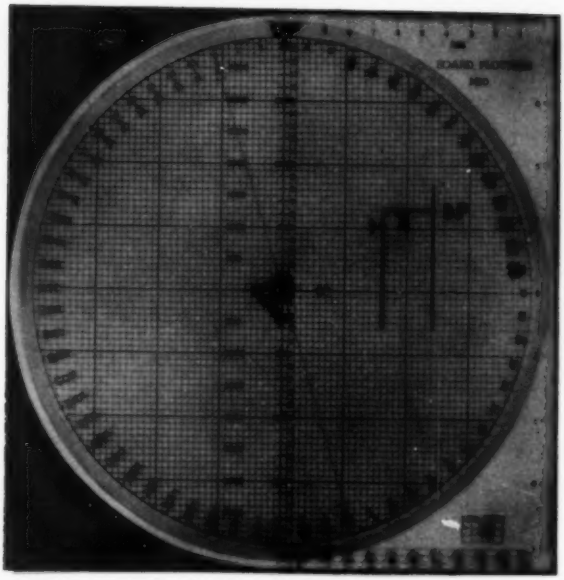


Figure 21.

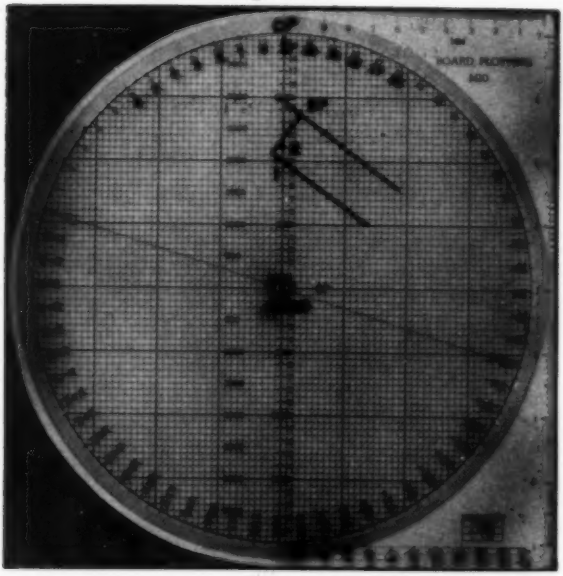


Figure 22.

5. It eliminates the need for ranging rounds which can be backplotted by the enemy to locate the gun positions.

6. It eliminates the necessity of training a large number of observers to compute correction factors, and requires only relatively few trained computers at the fire direction center.

7. The system does not depend entirely on the accuracy of the observer's azimuth to the target. Errors as great as 300 mils can be made without having appreciable effect on the adjustment. Larger errors will throw the bursts off the observer-target line; however, such errors are easily detected by the computer and the correct azimuth can be quickly determined by connecting two on-line bursts on the plotting board and reading the azimuth of this line.

The development of a fire control board to replace the M-10 Plotting Board is now under study. Such an instrument will no doubt simplify the plotting procedure and make it possible for the computer to compute accurate fire data more rapidly. However, the principles are the same regardless of the type of fire control instrument used.

Aerial Photo Intelligence

Cameras were used for taking pictures from the air long before the advent of heavier-than-air craft. Aerial photographs were made by cameras suspended from kites, captive balloons, and free balloons during the later stages of the 19th century. In the Civil War at least one photo was taken above the front lines from an observation balloon. During the Franco-Prussian War several photos were taken by the Germans from observation balloons for the purpose of securing military information.

The potentialities of using aerial photographs to obtain military intelligence were explored during World War I; however, the camera was used primarily for mapping.

After World War I, interest in photo intelligence diminished practically to the vanishing point. As a result, at the outbreak of the World War II the Armed Forces were caught with obsolete cameras and with no organization, equipment, or trained personnel to exploit what was to become a major source of intelligence.

The British and the other Allies were in a similar state of unpreparedness. With the Germans virtually in control of Europe, photo reconnaissance was suddenly catapulted forward as the solution to the problem of obtaining information of the continent and from within Germany itself. But, at the outbreak of hostilities in 1939, there was no photo reconnaissance or interpretation organization in the Royal Air Force to take over such an assignment. From this poor beginning the Royal Air Force developed one of the most scientific, efficient, and useful photo interpretation organizations of the war.

As a result of experience in the war, aerial photographic reconnaissance is recognized as one of the most prolific

sources of military information ever developed. Few secrets are hidden from the airborne cameras. Photo intelligence, the by-product of photo reconaissance, was first developed as a source of strategic intelligence for Allied planning staffs and air forces. From Dunkirk until the invasion of the continent on 6 June 1944, photo intelligence kept the Allies constantly and accurately informed on German defences and installations, both military and industrial.

The first large scale tactical use of photo intelligence by Allied Ground Forces was made by the British 8th Army at El Alamein. In this operation photo interpreters were attached to army and corps headquarters. The results obtained by these forward interpreters were so fruitful that from then on, it was accepted that front-line troops should be supplied with photographic interpretation.

In the American Army, the Sicilian Campaign was the field laboratory in which the techniques of army photo interpretation units were developed. In subsequent campaigns, the greater percentage of all information used in planning and executing operations was produced from aerial photo reconaissance.

In the Air Force, air photos were the primary source of intelligence. General George McDonald, A-2 Strategic Air Command in the ETO, said that in excess of 95 per cent of all combat intelligence utilized by Air Force elements in the theater was gleaned from aerial photographs.

These are convincing facts and figures. Nevertheless, as far as the front-line infantry units were concerned, the potentialities of aerial photos were not fully exploited even at the end of the war.

LIMITATIONS

Air photo intelligence is that military intelligence derived from aerial photographs. Because the source of aerial photographs is the photo reconnaissance plane, or, actually, the camera in the plane, consideration must be given to the operational and technical limitations of aerial photographic reconnaissance.

After action reports list *time* as the outstanding limitation of air photo intelligence. The four time consuming

processes between the request for information and the delivery of the desired information are flying, developing negatives, interpreting photos, and delivering the desired information. An extremely urgent request, the results of which can be transmitted by voice, requires five hours; an annotated print (a photograph on which identified objects are marked), eight hours; and quantity distribution of photos, twenty-four hours. These are minimum figures, assuming that an efficient system of liaison, coordination, and communication exists, and that all concerned are aware of the urgency.

Another limitation on the use of aerial photo intelligence is imposed because most aerial photos must be taken under favorable light conditions. For photographic purposes, the best light is obtained between the hours of 1000 and 1500 in the temperate zones. Several means of producing artificial illumination have been developed by the Air Force and experiments continue; however, night photographic reconnaissance is still greatly limited. For intelligence purposes, photographs taken by artificial light have a limited value.

Air photo intelligence is adversely effected by unfavorable weather conditions or by dense terrain. Poor flying weather may prohibit reconnaissance flights. With our present photographic equipment it is impossible to photograph terrain successfully through clouds. Dense terrain such as that found in the jungle makes it almost impossible to obtain any useful intelligence from aerial photography.

Enemy activity may preclude the procurement of air photo intelligence. Photo reconnaissance planes are unarmed and must evade enemy aircraft. Another limitation is imposed because photo reconnaissance planes must fly a straight and level course while photographing, thus becoming easy prey to enemy antiaircraft.

The lack of trained personnel imposes another limitation on the use of aerial photo intelligence. This, however, is a limitation which can be overcome with foresight and planning.

CAPABILITIES

Aerial photo reconnaissance is of strategic value to intelligence agencies because it permits them to make a comparative analysis of an enemy installation. A series of photographs of the same area taken at periodical intervals, will reveal the progress of enemy activity in the area. Information obtained from a comparative analysis of a particular enemy area is also of tactical value. An examination by qualified photo interpreters will show where the enemy is placing his defenses, the type of defensive installations, and the location of obstacles. To be of tactical value, however, this information must be in the hands of the troops before the actual reduction of the position begins.

Aerial photo reconnaissance makes it possible to conduct a rapid, detailed, and comprehensive study of the terrain. By use of photographs it is possible to analyze terrain deep in enemy territory as well as terrain to the immediate front and thus obtain terrain information which would otherwise have to be obtained by ground reconnaissance. Air photographs and terrain analysis studies placed in the hands of troops provide a highly accurate source of terrain information.

PHOTO INTELLIGENCE AGENCIES

Photo intelligence agencies are organic to the division and all higher units. Normally, these agencies are coordinated by the G-2. At army level, a liaison channel is maintained with the Air Force. For this reason requests for air reconnaissance missions are forwarded to army for action. Contrary to procedure in other types of intelligence, photo information and intelligence is usually disseminated from a higher to a lower echelon. In this manner higher units attempt to get adequate photo information and intelligence down to division and lower level before it becomes necessary to submit a request.

The key installations in the photo procurement and intelligence channels are shown in Figure 1. Assume for a minute that an infantry regiment is preparing to attack a deliberate defensive position and the regimental commander

has not received adequate photo coverage of his sector. A request is initiated by the regimental S-2, and forwarded through channels to the army G-2 Air. Army G-2 Air consolidates all requests for air reconnaissance missions and confers with air A-2. If the request is approved it is incorporated in the over-all photographic plan and forwarded through Air Force channels to a reconnaissance aviation group for action.

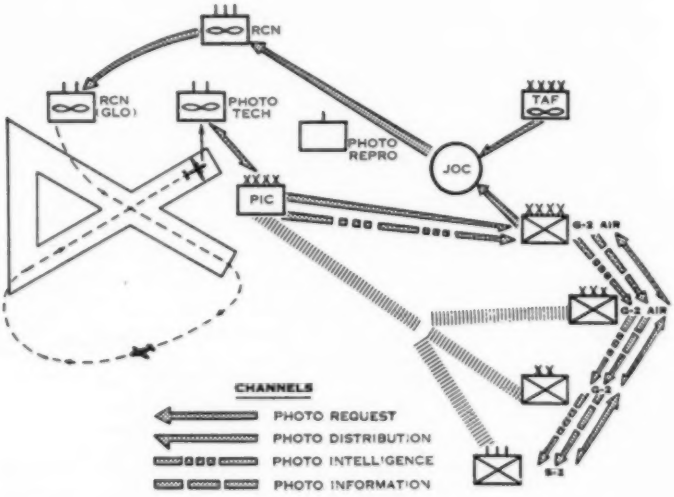


Figure 1. Schematic diagram showing aerial photo channels.

If, however, the regimental commander feels that this is an urgent request, the S-2 might telephone the G-2; G-2 would probably by-pass corps and radio army G-2 Air. G-2 Air of army consults with A-2 and A-3 and they determine how the request will be handled. If a plane is in the air, A-3 might direct it to fly the mission immediately.

When the reconnaissance plane returns from the mission, films are processed immediately. After the films are developed two prints are run off without delay—one is plotted on a master map and the other is sent to the photo interpreters for examination and interpretation. This examination is referred to as first phase interpretation. Any

important information detected by the interpreters is immediately sent to the requesting unit by wire or radio. Other prints are then run off and the interpreters make a detailed interpretation and prepare their reports. This procedure is called second phase interpretation. Dissemination of the photographs and reports may be made direct to the using unit by aircraft or motor vehicle or may be made through channels, depending on the priority established by the requesting unit. Normally, distribution will be made through channels.

PHOTO INTERPRETATION CENTER

A Photo Interpretation Center is set up at army level. This organization and its subsidiary installations are normally located on or near the air field. The functions performed by the Photo Interpretation Center are:

1. Interpret photos.
2. Prepare interpretation reports.
3. Prepare terrain analysis reports.
4. Make aerial mosaics.
5. Process and reproduce photos.
6. Prepare terrain models.
7. Deliver products to the using unit.

Much of the work performed by the Photo Interpretation Center is accomplished in advance of actual operations. Basic cover (first photos taken of an area), for example, is usually flown far in advance of the present front lines in order to cover probable areas of operation. The army G-2 Air will have sufficient advance information to inform the Photo Interpretation Center of contemplated operations long before they are made known to staffs of lower echelons. In this manner, army can make both a comparative analysis and a terrain analysis of a contemplated area of operations long before the analyses are actually needed by divisional units. When a division is actually alerted for operations in a specific area, the Photo Interpretation Center will be able to furnish basic cover of the division sector, annotated prints or mosaics of enemy defenses, detailed interpretation reports, and terrain studies.

The automatic flow of photo intelligence and information does not end with the beginning of the division operation. There will be a constant flow of photographs, in most cases daily front-line coverage, periodical and special interpretation reports, and photo intelligence in general. In the European theater, for example, when combat divisions reached the Siegfried Line they received annotated photographs, mosaics, and special interpretation reports showing the enemy defenses. Army interpreters had been studying the fortification months before the combat troops reached the position; consequently, the interpreters were able to make this detailed information available immediately.

The division G-2 should have sufficient knowledge of the Photo Interpretation Center to know what photo intelligence information he can reasonably expect from higher headquarters. If this information and material is not forthcoming, the G-2 must request it or be prepared to produce it in the division.

THE DIVISION PHOTO INTERPRETATION TEAM

During the early stages of the last war some individual in the G-2 section was normally assigned the duty of handling photographs; usually this meant filing and distributing photographs as soon as they were received from higher headquarters. Until trained photo interpreters were attached to a division, this was about all the G-2 section was qualified to do with the photographs and, because of a shortage of trained personnel, it was not until the later stages of the war that photo interpreters were made available to all combat divisions.

Photo interpretation personnel were organized as a seven-man team consisting of two officers and five enlisted men. Normally, one team was attached to an infantry division. The results obtained by photo interpretation teams proved their worth; by the end of the war using divisions were almost unaminous in recommending that photo interpretation personnel be organically assigned to infantry divisions.

Current Tables of Organization assign a photo interpretation team to each infantry division:

1 Captain, photo interpreter
1 Lieutenant, photo interpreter
1 Sergeant First Class, photo interpreter
3 Sergeants, photo interpreters
1 Private, driver

Two additional enlisted men are assigned to the G-2 section as photo interpreters. One is a sergeant first class, the other a sergeant.

In addition, three photo interpreters are assigned to the division headquarters battery of division artillery: a lieutenant, a sergeant, and a corporal. They are primarily concerned with locating appropriate artillery targets, but they work in conjunction with the divisions photo interpretation team, and information between the two units is exchanged at periodic intervals.

The value of photo interpretation for artillery units is made more obvious by captured enemy operation reports; at Anzio beach, for example, photo interpreters were so successful in locating German artillery positions that the enemy was forced to place his artillery much further to the rear than he had originally planned.

The photo interpretation personnel assigned to the division perform the dual function of a distribution agency and an interpretation agency. The chief photo interpreter is the officer-in-charge of the team. In this capacity he is responsible for planning photo coverage, for distribution of photographs, for interpretation of photographs, and for dissemination of photo intelligence. The photo interpretation team performs other miscellaneous functions which fall within the general category of photo interpretation. For example, they make special interpretations of roads and trails, river crossing sites, and bridging requirements for the engineers. In certain phases of an operation, photo interpretation personnel brief patrols for special missions using photographs as a basis. Frequently, they are required to interrogate prisoners of war or civilians who live within the area, again using photographs to orient them. They

also verify information which has been obtained from other sources.

TECHNIQUE OF PHOTO INTERPRETATION

A photograph in anyone's hands serves as an excellent map supplement. To a G-2 an aerial photograph is a precise document which is not easily influenced by false information deliberately planted by the enemy and which provides a large amount of accurate information. In the hands of a qualified photo interpreter, however, an aerial photograph becomes a valuable source of military intelligence.

The techniques which make it possible to extract detailed information from aerial photographs are stereoscopic study and comparative analysis. A stereoscopic study is merely reading a pair of overlapping photographs of the same area through a stereoscope. By this means, the two photos are fuzed into a single image and the photo interpreter is able to visualize depth. A comparative analysis is a study of a series of aerial photographs of the same area taken at periodic intervals to determine what changes have been made.

The stereoscopic study of any area is possible because photo reconnaissance missions are flown so that there will be 60 per cent overlap between pictures. That is, pictures are taken at such intervals that each object on the terrain will always appear on two photographs. To make the stereoscopic study, the photo interpreter orients the two photographs properly and views them through a stereoscope.

Comparative analysis is the basis of all combat photo interpretation. The amount of information gathered from the initial study of a series of aerial photographs of an installation is small compared to the accumulation of information gathered by periodic studies of the same area. This is true whether the area under study be a fortified line, a harbor installation, or a munition plant. Figures 2 through 5 are a graphic illustration of this principle.

Assume that a photo reconnaissance plane flies a basic cover mission over a strategic area far in the enemy rear. The data gained from these basic cover photographs is

illustrated graphically in Figure 2. At the time the basic cover mission is flown the only information of military value is the actual location of the highway net. This information is extracted and filed, and plans are made to photograph the same area at a later date.

Approximately three months later a second reconnaissance mission is flown over the same area. A stereoscopic study of the photographs obtained on this mission definitely indicates that the enemy is preparing to defend this portion of the highway net. Figure 3 illustrates graphically

Figure 2. Diagram of a road net extracted from a basic cover photograph.

the defensive installations that have been added since the basic cover mission was flown. Because of the enemy activity detected in this area, the Air Force is directed to fly reconnaissance missions over the same area at periodic intervals.

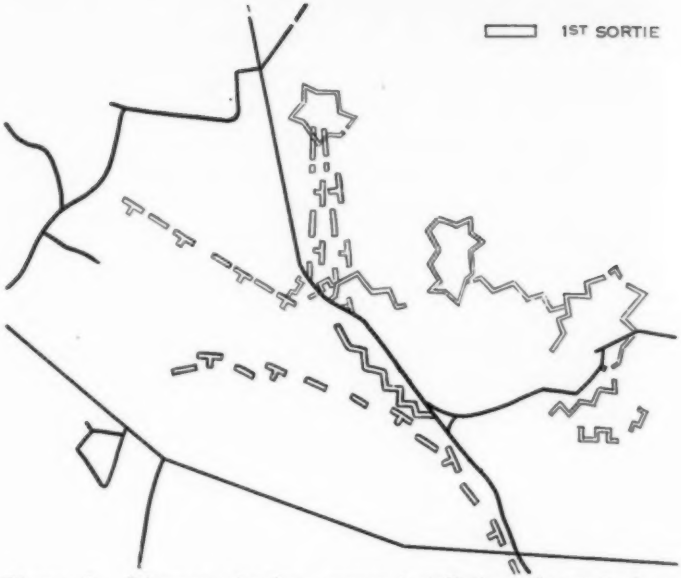


Figure 3. Diagram showing enemy installations detected three months later on an aerial photograph of the same area.

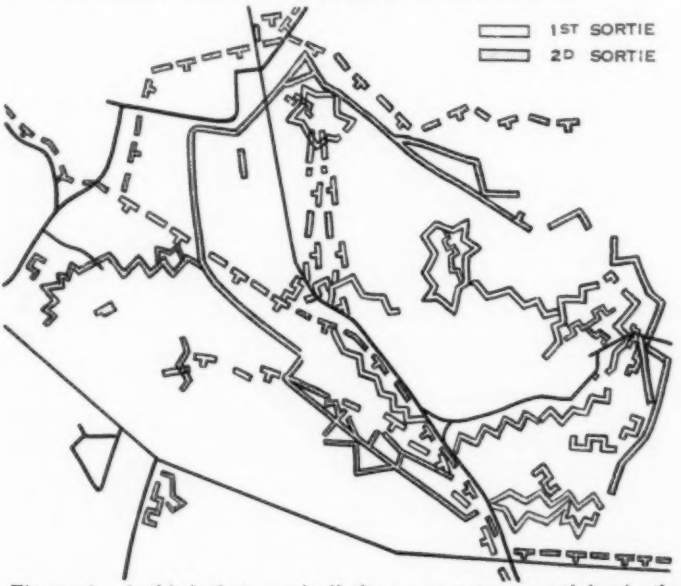


Figure 4. A third photograph discloses more enemy activity in the area.

Figure 4 illustrates graphically the information gleaned from photographs taken on the next reconnaissance flight. The enemy is digging more antitank ditches, stringing barbed wire, and erecting casemates and pillboxes. It is now obvious that the enemy is preparing a strong defensive installation around this portion of the highway net.

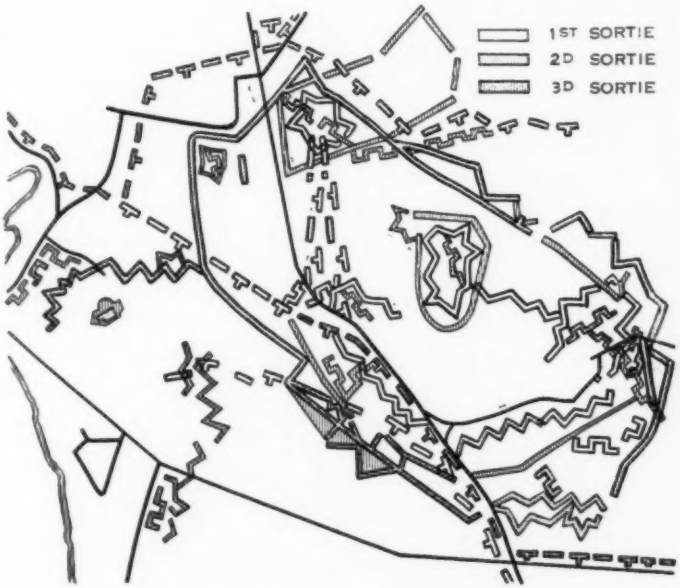


Figure 5. The fourth photograph discloses the complete pattern of enemy defensive installations.

Approximately two months later the combat troops are approaching the area and plans are being made to reduce this enemy strong point. Figure 5 illustrates the additional installations that have been added to the defensive position within the last sixty days. The enemy has again extended his wire, added more casemates and pillboxes, and surrounded his strong point with antitank ditches.

Based on the information gained from this comparative analysis extending over several months, the attacking

troops have adequate information to determine whether they should by-pass the enemy installation, subject it to intensive bombing, attack it frontally, or attack it from the flank. In addition, the attacker can determine the best possible route for approaching the position and the tactics and weapons to be employed in demolishing the strong point. If forewarned is forearmed, the attacker is indeed well armed with this information.

INTERPRETATION REPORTS

Information extracted from the interpretation of aerial photographs is disseminated by interpretation reports. A report may be written or oral; it may be published as an overlay, published as an annotated print, or published by a combination of these methods. The primary objective is to get the information to the using unit in the best possible form.

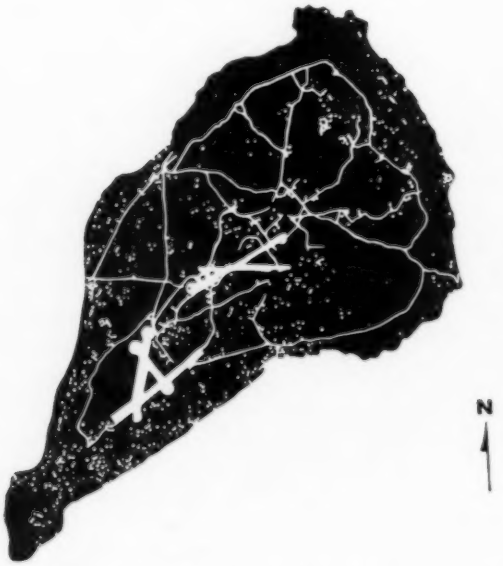


Figure 6. Defenive installations on Iwo Jima as extracted from aerial photographs.

The following extracts from interpretation reports give a general idea of the type of information included.

Figure 6 is a reproduction of a map prepared by the United States Navy prior to the invasion of Iwo Jima. This is not the entire report but merely a single graphic illustration from the 40-page report. Each of the white dots on this map represent a defense position. The written portion of the report gave detailed information concerning each white dot. It explained what type of installation it was, how it was constructed, what type of gun was emplaced in the installation, and where the gun was pointed. The value of this type of information when attacking an objective such as Iwo Jima is self evident.

Figure 7. A low level oblique prepared as an annotated print.

When the Allies were preparing to invade the continent of Europe, literally thousands of pages of photo interpretation reports were prepared and disseminated. Interpreters

worked over a year preparing for the invasion. For example, one 600-page report presented a detailed foot-by-foot study of the highway system of the Mediterranean coast of France. Other reports gave detailed information concerning every foot of landing beach. In these reports the texture of the sand, location of immediate defenses on the beach and deep defenses in rear of the beach, were shown graphically. As a result of these reports, engineers were able to determine their priorities for road building, commanders were able to avoid soft-sand beaches, and the Navy was able to clear many under-water obstacles prior to the landing.

The oblique photograph shown in Figure 7 is an interpretation report consisting of a single annotated print. It was prepared to brief the skipper of an assault boat on the conditions he would find at his predetermined landing spot. If a picture is worth a thousand words, this annotated oblique print showing the location of two machine-gun positions was certainly worth a million words to the skipper who had to land his craft near the jetty. This is the scope of aerial photo intelligence; it is as broad as the highway net of southern France; it is as definitive as the location of two machine guns on a jetty on Akyab Island.

II
HISTORICAL EXAMPLE

Just as the proof of the pudding is in the eating, so is the value of photo interpretation determined by visible results. The following example of an interpretation report, or rather a portion of an interpretation report, will give a specific idea of the intelligence that can be derived from aerial photos by expert photo interpretation. When looking at the printed reproduction of these photographs, keep in mind that because of technical difficulties the printed reproduction is not nearly as clear as the actual glossy photograph.

On 2 October 1943, when the British 46th Division and the 23d Armored Brigade were ordered to move from Naples to the Volturno River they were furnished copies of Italian

terrain maps and an aerial photo interpretation report. The interpretation report contained an extensive evaluation of the defensive installation at the Italian village, Villa Literno. (See figure 8.)

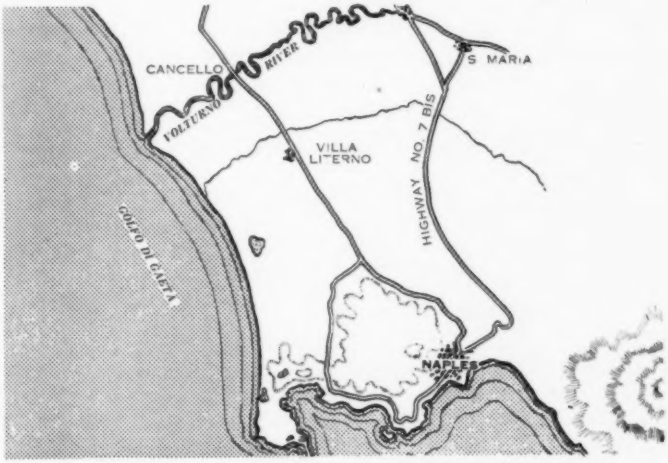


Figure 8.

Figure 9 is a reproduction of a small section of the 1:100,000 and 1:50,000 Italian maps of this area. An examination of the circled areas on these two maps discloses several discrepancies. For example, the town is named Vico Di Pantano on the large scale map, but it is named Villa Literno on the small scale map; the railroad that runs parallel to the northwest-southeast road is not even shown on the small scale map. Obviously, maps with these discrepencies have only limited value for military purposes. Because of their tactical importance the two areas circled on the map were subjected to an aerial photo study.

The aerial photo mosaic shown in Figure 10 represents the first step in making the air reconnaissance report on Villa Literno. The areas circled in white on this mosaic are the same as those circled on the terrain maps. These photographs were taken on 17 September 1943. Even on this

reproduction, which is a poor substitute for a large glossy photograph, it is easy to see the additional information that can be gathered from an aerial photograph. For example, the olive groves around the town are visible, small ditches and hedgerows which form boundaries of the fields stand out on the photograph, and the railroads and railroad yards which are not even shown on the large scale map can be easily identified on the photograph.

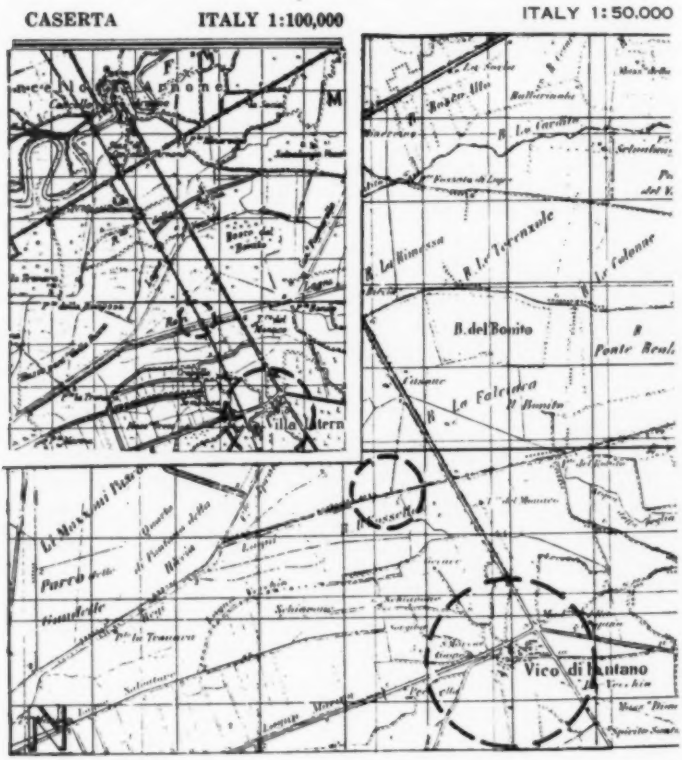


Figure 9. Portions of the Italian maps furnished the attacking British troops.

On 21 September 1943, the area was photographed again. Figure 11 shows a larger scale photograph of the town. Much additional detailed information is gained from this photograph but, with the exception of the identified anti-tank ditch, no additional military intelligence is visible. This photograph serves as a map supplement, however, it is inadequate for detailed photo interpretation.

The stereopair shown in Figure 12 served as the actual basis for the photo interpretation report. The photo interpreters stated that all of the objects circled in black on the stereopair were hostile defensive installations.

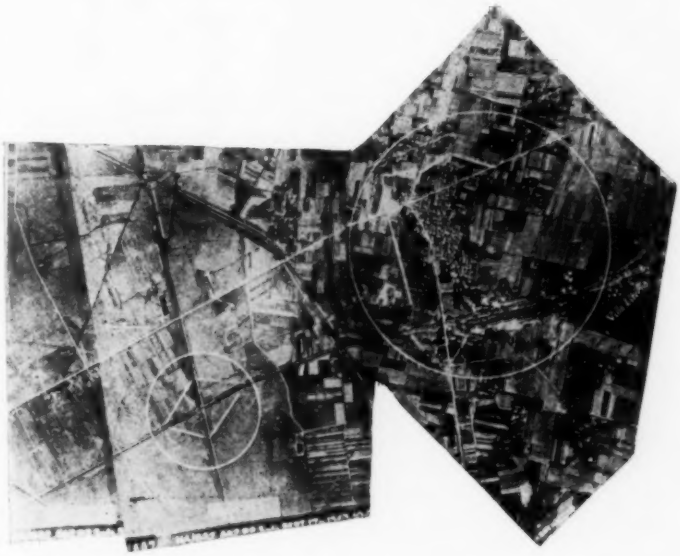


Figure 10. Aerial mosaic of the circled areas in Figure 9.

Based on this stereoscopic study, the photo interpreters prepared an annotated print as shown in Figure 13. Each object circled once on the annotated print was determined to be a pillbox, and each object circled twice was determined to be a casemate.

Figure 14 is a graphic portrayal of the defense plan of

Villa Literno as extracted from the aerial photographs. Note the principal roads and railroads which can be used to orient the rest of the information on this graphic picture. Note also, the location of pillboxes and casemates, the antitank ditch, the personnel trenches, and the location of occupied and unoccupied gun emplacements.

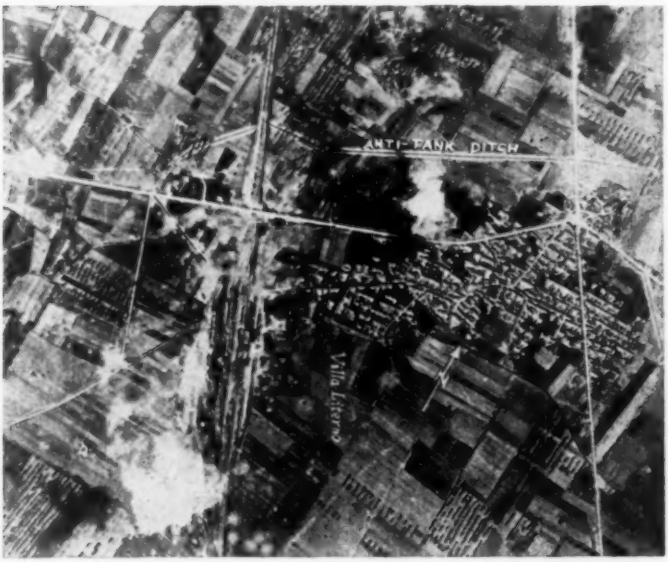


Figure 11. The only additional information of military value on this photograph is the location of the identified antitank ditch.

Figure 12. A study of this stereopair discloses many defensive installations in and around Villa Literno.

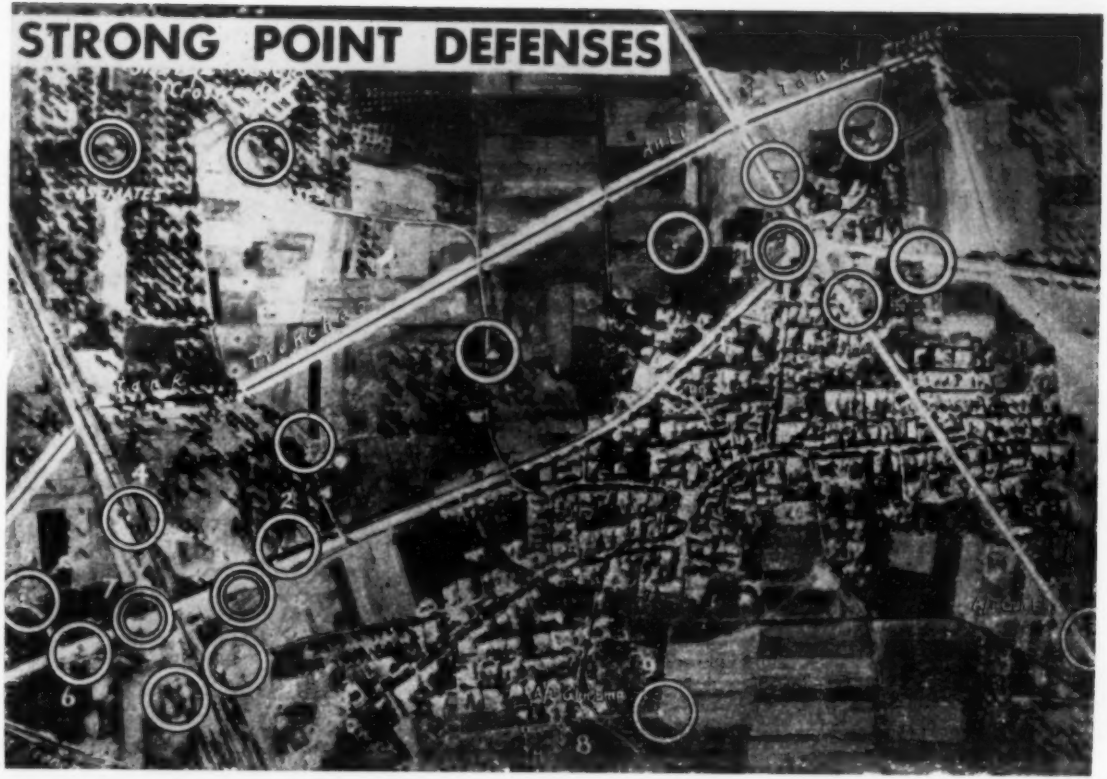


Figure 13. This annotated photograph shows specific defensive installations located by a stereoscopic study of Figure 12.

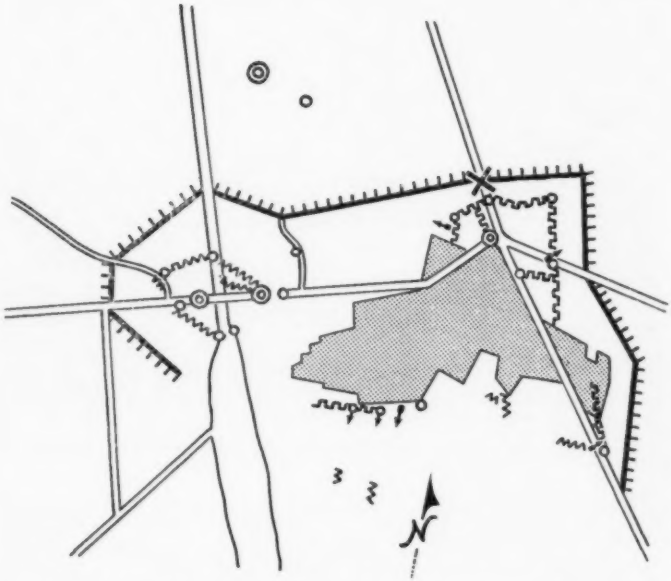


Figure 14. A graphic chart of the defenses in and around Villa Literno as extracted from aerial photographs.

Figure 13. This annotated photograph shows specific defensive installations located by a stereoscopic study of Figure 12.

In this particular operation the photo interpreters carried the process one step forward. A ground check was made of the defensive installations. The photographs shown in Figures 15, 16, and 17 illustrate the accuracy of skilled photo interpretation. The interpreters identified objects numbered 1, 2, 3, and 5 in Figure 12 as pillboxes and object number 4 as a casemate. Ground photographs substantiated these identifications.

The small circled area north of Villa Literno (see Figure 10) which appears to be an intersection was studied critically during the interpretation and after the action took place. The interpreters determined the intersection to be a triple canal crossed by a railroad and the stereoscopic study revealed numerous enemy installations in the vicinity. Ground photographs taken after the position was captured

Figure 15. A ground photograph of the object numbered 1 on the stereopair in Figure 12.

Figure 16. A ground photograph of the casemate numbered 4 on the stereopair.

Figure 17. A ground photograph of the pillboxes numbered 2 and 3 on the stereopair.

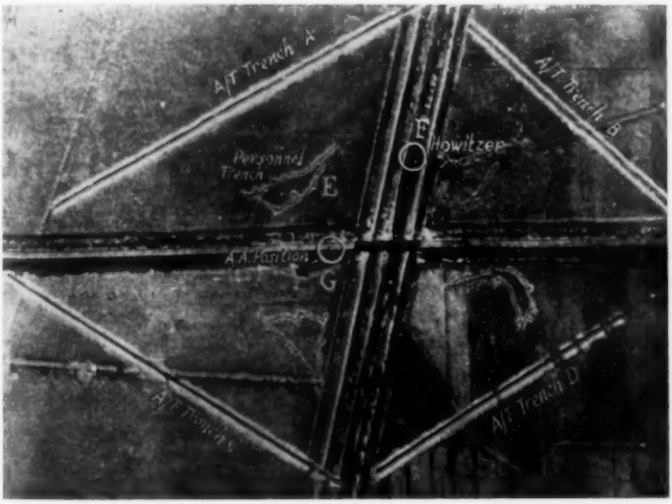


Figure 18. Annotated aerial photograph of the enemy defenses around the railroad intersection north of Villa Literno.

proved the continued accuracy of the interpretation. (See Figures 18 and 19.)

The value of this type of intelligence is obvious; unfortunately however, detailed front-line aerial photo intelligence such as the British had at Villa Literno was the exception, not the rule. In World War II aerial photo intelligence was used more extensively in the Pacific theater than in any other theater. But even in the Pacific, the potentialities of aerial photographs and aerial photo intelligence were not fully exploited as far as the individual infantryman was concerned.

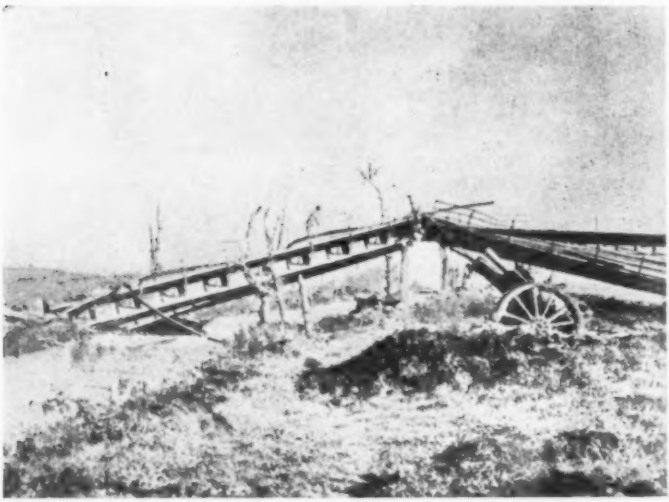


Figure 19. A ground photograph of the gun position marked S on the annotated print.

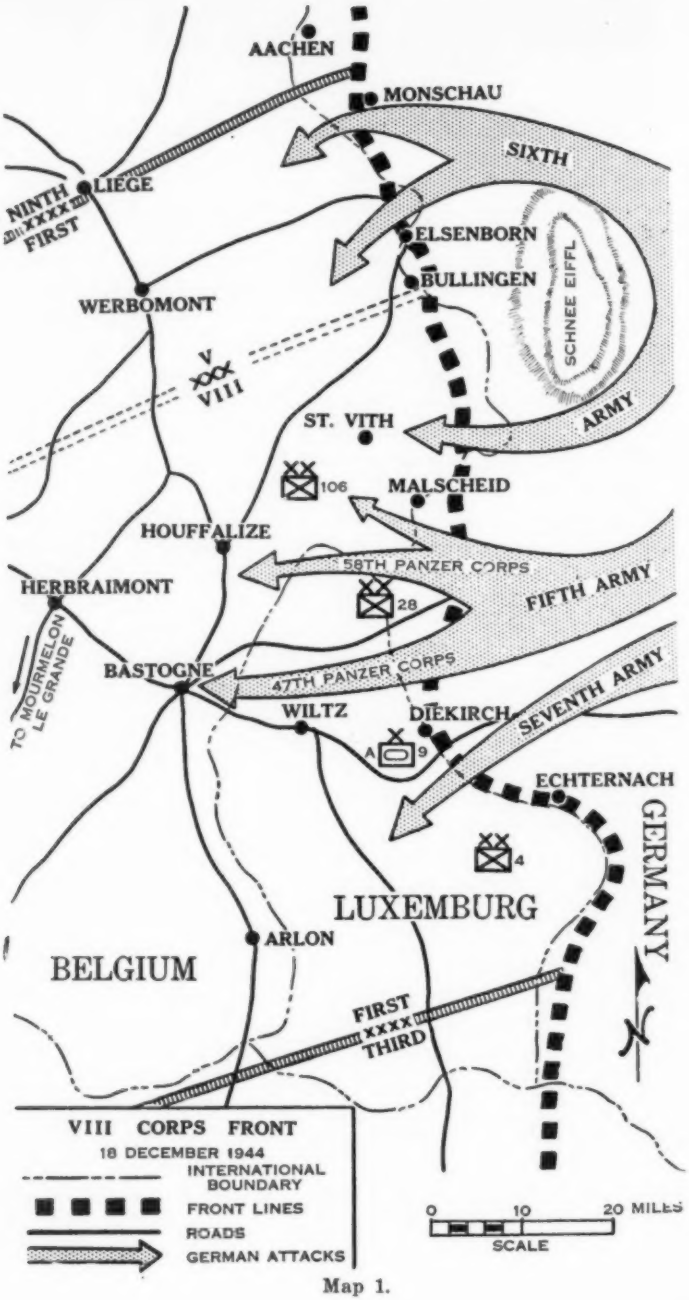
The need and importance of photo intelligence to front line units was unquestionably demonstrated during the war. As a result a photo interpretation team has been assigned to the infantry division. With the addition of this team and other interpreters to the division, the infantryman now has available in his own organization the facilities for exploiting aerial photographs for his particular use, that is for immediate close-in, front-line interpretation.

A Meeting Engagement at Bastogne

The highway was clogged with individual stragglers and fragments of units. Some on foot, some on vehicles, but all of them moving westward—away from the enemy. Wheeled and track vehicles raced along the narrow road stopping, turning, or leaving the roadway at will. Cargo trucks towing field headquarters trailers were threading their way to the west. Against this uncontrolled stream of traffic the eastward-moving personnel carriers of the 101st Airborne Division came to a halt. The long convoy closed on the leading vehicle and traffic halted from both directions. The rear elements of the VIII Corps couldn't evacuate Bastogne and the combat elements of the 101st Airborne couldn't enter the town.

A similar state of confusion existed within Bastogne. VIII Corps Headquarters was, for all practical purposes, isolated. It had been out of contact with its front-line units all day 18 December and consequently knew little of the situation on the corps front. Since the corps headquarters had suddenly found itself on the front line it was in the process of moving to the rear. A majority of the corps staff sections had closed out operations and were in the traffic jam on the road leading west from Bastogne.

The events leading up to the German breakthrough in the Ardennes sector and the subsequent defense of Bastogne are well known. Allied troops had been diverted from this sector in preparation for a general offensive to the north. The Germans concentrated three Panzer armies west of the Ardennes and on 16 December launched a three-pronged drive designed to reach Antwerp and to drive the Allies back across the Meuse. Tactical surprise was complete. The thinly-held Allied line broke before the fierce armored assault. To halt the German attack, Supreme Headquarters committed its reserve—the XVIII Airborne Corps consisting of the 82d and 101st Airborne Divisions.


AACHEN
MONSCHAU
SIXTH
LIEGE
NINTH
XXXX
FIRST
ELSENBORN
BULLINGEN
SCHNEE EIFFL
WERBOMONT
V
VIII
ARMY
ST. VITH
106
MALSCHEID
HOUFFALIZE
58TH PANZER CORPS
FIFTH ARMY
HERBRAIMONT
28
TO MOURMELON LE GRANDE
BASTOGNE
47TH PANZER CORPS
SEVENTH ARMY
WILTZ
DIEKIRCH
A
9
ECHTERNACH
GERMANY
4
LUXEMBURG
ARLON
BELGIUM
FIRST
XXXX
THIRD
VIII CORPS FRONT
18 DECEMBER 1944
INTERNATIONAL BOUNDARY
FRONT LINES
ROADS
GERMAN ATTACKS
0
10
20 MILES
SCALE

Map 1.

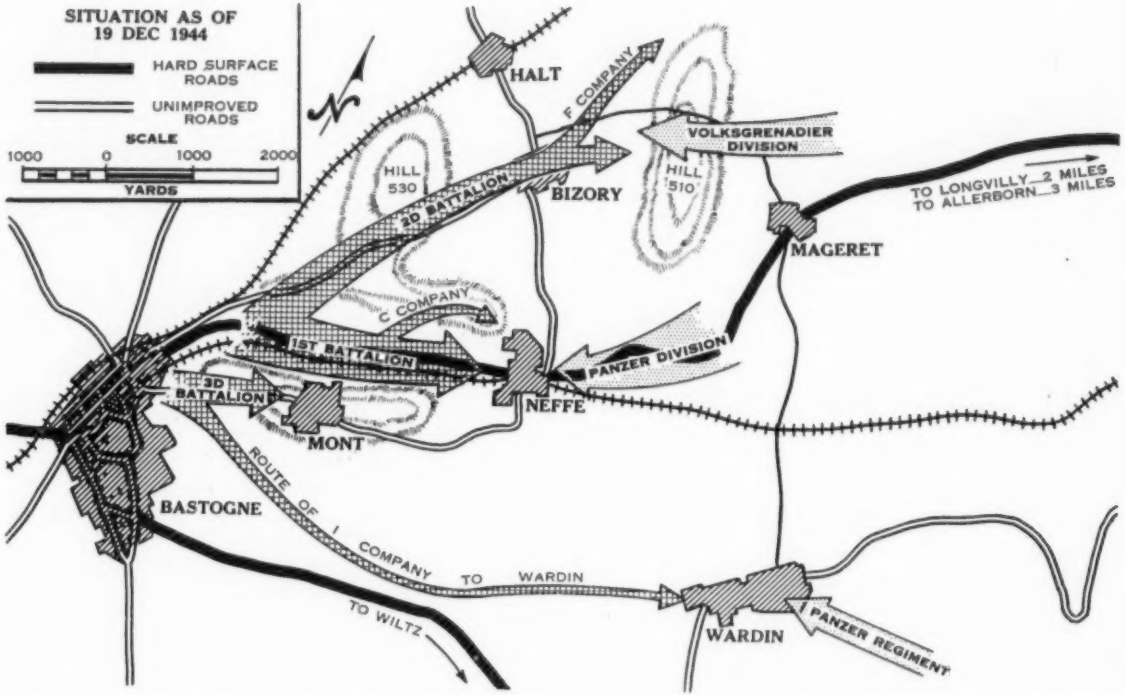
With only 24-hours notice, the 101st Airborne Division hurriedly prepared for the move. The men who had been on pass in Brussels, Paris, Reims, and the Riveria were recalled. Supply officers issued all of the clothing and weapons they could locate to replace that which had been lost in 73 days of sustained combat in Holland. Efforts were made to find out what the situation was at the front but no information was available. With companies under strength, men not fully equipped for the cold wet fighting ahead, and officers ignorant of the tactical situation, the division moved out at 1400 on 18 December. At a crossroad near Herbriamont, the column was diverted to Bastogne.

Responsibility for the defense of Bastogne passed to the 101st Airborne Division as soon as the leading elements arrived. Because the division had received very little information it was necessary to start from the beginning to build up the situation. The confusion made it impossible to get a clear impression of just what was going on. As an immediate solution and in order to gain something tangible on which to base a plan for the defense, the division commander decided to send a regimental combat team out along the Bastogne-Longvilly Road the next day—19 December—to develop the situation, meanwhile holding the remainder of the division in an assembly area in the vicinity of Bastogne. (See figure 2.)

As the 501st was the first unit of the division to arrive at Bastogne, they were assigned this mission.

The regimental commander felt that his mission "to move along the Bastogne-Longvilly Road to develop the situation,"—was too wide in scope and requested that he be assigned a more definite mission. The division commander amended the original mission by ordering: "Move out the Bastogne-Longvilly Road at 0600, 19 December to contact the 110th Infantry Regiment at Allerborn and to seize the road junction two miles to the east of Allerborn." (See figure 2.)

Actually the division commander had little hope that the regiment would find the 110th Infantry at Allerborn. Since


SITUATION AS OF
19 DEC 1944
HARD SURFACE ROADS
UNIMPROVED ROADS
SCALE
1000 0 1000 2000
YARDS
HALT
F COMPANY
VOLKSGRENADIER DIVISION
HILL 530
HILL 510
BIZORY
2D BATTALION
TO LONGVILLY—2 MILES
TO ALLERBORN—3 MILES
MAGERET
C COMPANY
1ST BATTALION
PANZER DIVISION
3D BATTALION
NEFFE
MONT
BASTOGNE
ROUTE OF I COMPANY TO WARDIN
TO WILTZ
WARDIN
PANZER REGIMENT

Map 2.

their regimental headquarters was located scarcely more than 11 miles from corps headquarters, and since there had been no contact for more than 24 hours, there was little chance that it was still in that locality.

The commander of the 501st Parachute Infantry had only the mission upon which to base his plans for the operations on 19 December. This situation, however, was not much different from other situations in which the unit had been engaged, except that the regiment could not count upon the surprise of a parachute landing. As for lack of information, the regiment was accustomed to going into a situation about which little was known.

As the commander estimated the situation, the regiment would probably meet a strong enemy, well organized and fired with the confidence of recent victory. Accordingly, he decided that methodical caution should govern the scheme of maneuver and the actions of the regiment. Based upon this brief analysis of the situation, instructions were issued to battalion commanders to develop the situation at the point of contact without trying to by-pass the enemy in order to get to the objective. In his words, "Don't try to beat the enemy to death." Later events proved this to be a most provident set of instructions.

Other than a general discussion of the mission, the orders for the employment of the regiment simply consisted of a route of march, the order of march, and the objective. With the 1st Battalion as advance guard the regiment was to move in the same order and with the same attachments as in the motorized move to Bastogne. The division reconnaissance platoon was to scout the area to the front and flanks of the 1st Battalion.

THE MOVEMENT TO CONTACT

At 0600, 19 December, the regiment moved out in column. Movement through Bastogne was difficult since the roads were still jammed with two-way traffic. Unfortunately the division reconnaissance platoon by mistake took the wrong road, and because of the traffic congestion, was unable to join the cloumn.

It was a curious sight to observe the regiment file through the narrow streets in the murky darkness. Everywhere the evidence of inadequate combat equipment bore mute testimony to the haste with which this force had been assembled and rushed into combat. Some men who had returned from pass just in time to jump aboard the trucks, were still wearing Class A uniforms with only a helmet or a rifle added. Despite the effort to get equipment before moving, shortages still existed in overcoats, steel helmets, cartridge belts, and crew-served weapons. The morale, however, was high because the men's thoughts were divided between the challenging situation which lay ahead of them—of which they knew nothing except the exceedingly exaggerated stories they had gleaned from retreating stragglers—and the recent memories of a pass in Paris, Rheims, or Brussels.

The road over which the column moved ran through a narrow valley flanked on either side by ridges running generally east and west. For the most part the area was farm land or pasture, uninterrupted except for small, regularly shaped plantations of spruce trees which were sparsely scattered on the landscape. The terrain was ideally suited for defense. Excellent fields of fire and good observation were available over the gently rolling barren slopes.

The two principal roads in the immediate area of the column were the Bastogne-Wiltz Road and the Bastogne-Longvilly Road. (See figure 2.) Both of these roads were hard-surfaced highways in excellent condition. The remaining roads were unimproved and little better than trails.

The column moved slowly along the Bastogne-Longvilly highway. A dense fog limited visibility to scarcely more than 300 yards. The advance elements had to reconnoiter the route as they moved, delaying the column by the stopping, starting, and accordion action. When the head of the 1st Battalion arrived two miles east of Bastogne, the center of the column came under small-arms fire from a ridge on the north flank. The battalion commander promptly dispatched a platoon from Company C to investigate the situation. In moving through some woods about 200 yards

from the road the platoon flushed a squad of Germans. After a short exchange of shots most of the Germans withdrew to the north and escaped in the fog. Two prisoners were taken in the action; they were from a reconnaissance unit of a Panzer Division.

Flank guards had been placed to comb the ridge line on both flanks, but due to the fog the flank security had moved almost through this German position without either force becoming aware of the presence of the other. Not until the Germans had heard movement on the road and moved closer to investigate did they discover the large American force and open fire. The enemy fire did no damage, and was unimportant from the standpoint of the movement, but the fact that the enemy was so close to Bastogne was extremely significant.

Meanwhile the head of the column continued east along the road toward Neffe. Approximately 500 yards west of Neffe, where the road ran straight and level, a heavy volume of small arms, automatic weapons, and direct fire from tanks raked the 1st Battalion column from straight ahead. The men dove into the ditches on either side of the road and the leading elements opened fire on an enemy column which was moving down the road from the vicinity of Neffe. At this time the 1st Battalion Commander judged that he faced approximately two platoons of infantry supported by tanks. What he did not know was that he had met head on with the leading elements of a Panzer Division. Confronted by an enemy force to his front and exposed by an uncovered north flank, the battalion commander ordered Company C, second company in the column, to move onto the high ground to the left of the road and attack southeast to envelop what he thought was a roadblock at Neffe. At the same time he ordered Company B, the lead company, to push forward astride the road toward Neffe.

When Company C arrived at a position about 400 yards from the Neffe-Bizory Road, it came under the same type of fire that had pinned Company B to the ground. In addition, tanks were now firing into Company C at long

range from the southwest slopes of Hill 510. (See figure 2.) Unable to advance farther, the men took whatever cover was available on the barren slope and began to dig in.

The ridge line along which the company had been moving fell off sharply into the same valley in which Neffe was situated. The Neffe-Bizory Road ran along the bottom of this valley. Approximately 500 yards to the east of the road the ground gradually sloped up to the crest of Hill 510. The enemy lodged at Neffe and on the high ground near Hill 510 controlled the barren slopes to the west and the Neffe-Bizory valley. Companies B and C were now almost on line and engaged with the enemy all along the front. Both the advance of the enemy and the advance of the 1st Battalion were apparently halted for the moment, and the opposing forces engaged each other with rifle fire at 400 yards range.

The fire which the 1st Battalion was receiving was not coming from dug-in defensive installations. This was strictly a meeting engagement; the enemy armored and infantry reconnaissance units had been moving toward Bastogne. The 1st Battalion commander had to base his course of action upon what he had seen and could reasonably expect, and, accordingly, decided to develop the enemy to his front rather than to by-pass them and proceed on to the objective.

By 1030 Company B had been able to advance down the highway only a scant 200 yards. One platoon of the company had moved south of the road in an effort to approach Neffe from the south. This platoon had advanced to a position about 150 yards from Neffe, where it established a strong point in a stone house south of the road and overlooking Neffe from a distance of approximately 100 yards. Company C was held up in the valley by enemy fire from Neffe and from Hill 510. Company A had moved off the road and had gone into reserve in the vicinity of a quarry approximately 400 yards to the rear of Company B. Battery B, 907th Glider Field Artillery Battalion, had also gone into position in the vicinity of the quarry, and was delivering observed fire upon the enemy armor and infantry along the road.

By this time it was apparent that the regiment was faced with an enemy of armor and infantry which, judging from the volume of fire, appeared to be increasing. Contact had been made at scattered points along the north flank, through enemy hit and run actions. These engagements had done little except to harass the movement of the column; however, they did emphasize that the left flank was dangerously exposed. The right flank was equally exposed, but so far there had been no enemy movement from that direction.

In order to determine whether the enemy was holding a continuous line to the north of Neffe and to cover the left flank of the column, the regimental commander ordered the 2d Battalion to attack northeast to seize Bizory (see figure 2) and the high ground in that vicinity. In the event the enemy did not hold a continuous line, he planned to continue the advance toward Mageret, leaving the 1st Battalion to hold at Neffe. He reasoned that with the capture of Mageret the 2d Battalion would be sitting astride the enemy's line of communication and thus make his position untenable.

The 2d Battalion moved out to the northeast with companies in column and by 1200 had captured Bizory without opposition; however, the battalion was receiving fire from Neffe and the southern slopes of Hill 510. To exploit their initial success, the battalion was ordered to move cross country and seize Hill 510, Mageret, and the wooded hill mass overlooking Mageret from the north. (See figure 2.)

The 2d Battalion left Bizory at approximately 1245 and advanced across the bottom of the valley east of Bizory. The leading elements of the assault companies had crossed the valley and started to advance up the side of the objective when they were taken under fire by automatic weapons and direct fire from tanks on the crest of Hill 510. An enemy column of five armored cars and two Mark IV tanks, followed by an estimated two platoons of infantry had observed the 2d Battalion moving across the valley and took it under fire at a range of 300 yards. The 2d Battalion immediately returned fire but being on lower ground was at a distinct disadvantage. Long bands of grazing fire swept down the slopes into the battalion column. Return

fire from the 2d Battalion kept the enemy infantry pinned to the ground, but the two Mark IV tanks moved about on the ridge firing almost at will. The tanks were out of range of the bazookas, and for the moment were safe from any heavier weapon, for the 57-mm antitank guns which were supposed to be attached to the 2d Battalion had been caught in the traffic jam in Bastogne and had not yet joined the column.

Unable to continue the attack on Hill 510, the two assault companies of the battalion sought whatever cover was available in the floor of the valley and the fire fight became stabilized. The surprise of the meeting and the initial outburst of fire had taken the impetus of advance from both the enemy and the 2d Battalion.

Company F, which was following the assault companies to the left rear, was not exposed to fire from the hilltop and was able to maneuver around the north flank and seize the wooded hill mass overlooking Mageret from the north. Company F's action to the rear of the enemy diverted considerable pressure from the front of the 2d Battalion but efforts of the two assault companies to advance farther up the slopes of Hill 510 were unsuccessful.

Although they did not know it at the time, the force which the 2d Battalion engaged was a reconnaissance element of the 26th Volksgrenadier Division which was advancing abreast the panzer division toward Bastogne. This division had been specifically committed to attack Bastogne from the northeast.

The unexpected engagement had the same reaction upon the commander of the enemy force and the commander of 2d Battalion. Each force had been advancing with caution, and upon contact, each commander abandoned his plan and waited for the situation to develop. The same situation had occurred in the 1st Battalion sector. The shock of the initial meeting caused both forces to recoil and neither pressed their initial advantage.

In order to cover his exposed south flank the regimental commander at 1230 ordered the 3d Battalion to secure Mont, a small hamlet located on a plateau southeast of Bastogne. He further directed this battalion to dispatch one

company on a reconnaissance mission to Wardin with instructions to withdraw if they encountered the enemy in force. Otherwise, the company was to secure and hold the town. A straggler had reported the existence of a friendly armored road block at Wardin but regiment had no authentic information on its location or enemy activity in that area. Company I moved out on the reconnaissance mission at 1245. (See figure 3.)

Mont fell to the 3d Battalion, less Company I, at 1400 without opposition. However, the advance eastward over the rolling plain met with strong resistance from tanks and infantry located south of Neffe. Consequently the advance of the 3d Battalion was halted along the high ground east of Mont, and the battalion took up a defensive position covering the regimental south flank.

The terrain in front of the 3d Battalion was pasture land crisscrossed with numerous five-strand barbed wire fences which divided the area into many rectangular compartments. These fenced-in compartments had apparently been constructed as cattle feeding pens, but now they served as an effective wire barrier.

Company I, in the meantime, was having trouble at Wardin. After swinging to the south and following a route roughly parallel to the Bastogne-Wiltz highway (see figure 2), the company contacted a 10th Armored Division road block about 2,000 yards from Wardin. The personnel at the road block seemed to know little about the situation so without wasting time the company proceeded toward Wardin. When the head of the column arrived at the outskirts of the town it came under small-arms fire, but the company deployed and pushed on into the town without too much difficulty. Upon entering the town the third platoon circled around to the northeast to establish a road block while the other two platoons cleaned out the town. German soldiers who were routed from the houses were forced into the road block established by the 3d Platoon on the outskirts and were either killed or captured.

By 1430 the town was under control of Company I. While the 1st and 2d Platoons were reorganizing and discussing their recent success, firing broke out from the 3d

Platoon road block on the eastern edge of town. At the same time eleven Panther tanks carrying German infantry rumbled out of the woods approximately 300 yards southeast of Wardin. The company commander gathered what force he could get together quickly and beckoned them to follow him to the southern outskirts where they engaged the German tank formation with machine guns, rifles, and bazookas. Ignoring this fire the tanks proceeded to within 100 yards of the town with the infantry still mounted on the tanks and firing as they came. The company commander ordered his force to fall back upon the town, but four Panther tanks which had broken through the 3d Platoon road block were already running amuck in the town. The company commander then gave the order for his force to withdraw by two's and three's and to escape as best they could to the north. He stayed behind with five other men to cover the retreat of the remainder of his company. Such men of Company I as were lucky dodged in among the buildings to escape the fire and escaped to the north.

The engagement had been expensive. Of the 94 men who had gone to Wardin, only 33 returned to Bastogne. Every officer and most of the noncommissioned officers were lost. In Bastogne the 1st Sergeant reorganized and took command of the remainder of the company. Although the exact number of casualties the enemy suffered is undetermined, it is known that two Panther tanks were knocked out by bazooka fire and that many Germans were shot from their perch on the tanks.

Word of the disaster had not reached the regimental commander when at 1530 he decided to abandon further effort to advance to the east. With his 1st, 2d, and 3d Battalions engaged on a broad front and with indications that a strong enemy force was attacking toward Bastogne, it was clear that the best course of action was for the regiment to defend the high ground in the vicinity of their existing front lines. This decision was the initial step which paved the way for the successful defense of Bastogne.

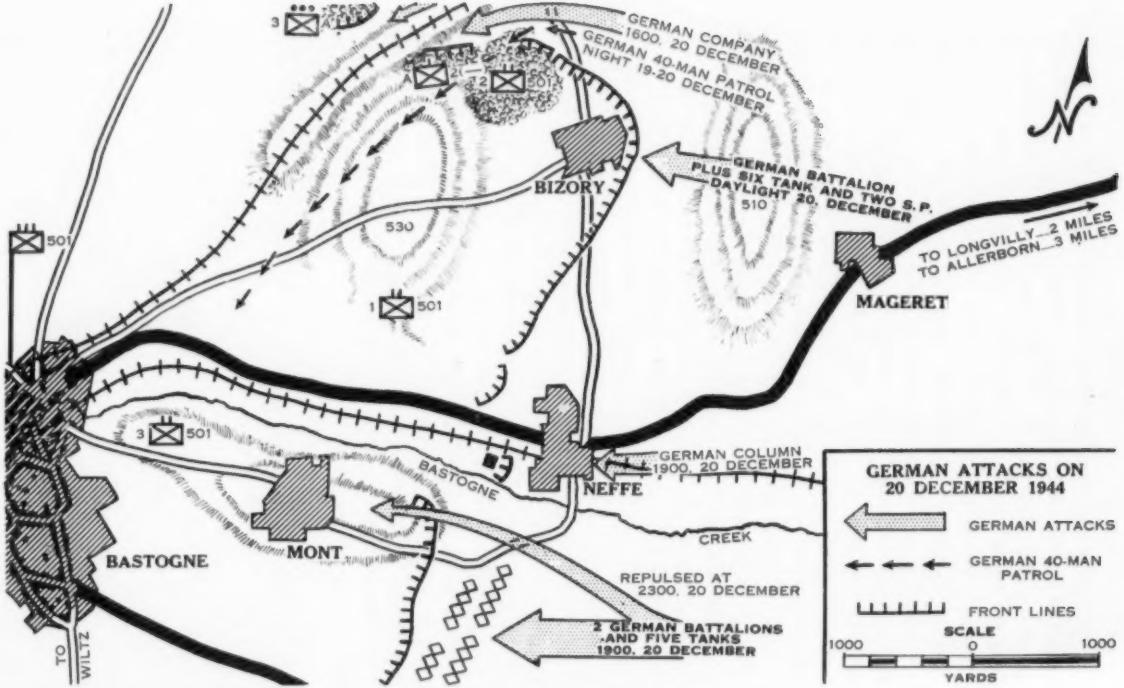
At nightfall on 19 December all three battalions of the 501st Parachute Infantry were on line and in contact with the enemy. The battalions had adjusted their lines in

each sector to take advantage of dominating terrain and were digging in for the night. (See figure 3.) With the exception of Company A, which was the reserve company of the 1st Battalion, and the remnants of Company I, the regiment was entirely committed. The regimental commander requested a battalion from division with which to constitute a reserve. Accordingly a battalion from the 327th Glider Infantry was attached to the 501st Parachute Infantry at 2000 19 Dec. On the north the 2d Battalion protected the flank of the regiment along the woods northeast of Hill 530. The 1st Battalion refused its flank along the high ground overlooking the Bastogne-Longvilly Road, and the 3d Battalion protected the regimental south flank along the Bastogne-Wiltz highway. The regimental command post was established in a monastery on the eastern edge of Bastogne. The 907th Glider Field Artillery Battalion was in direct support of the regiment.

Throughout the night of 19-20 December small groups of men whose units had been isloated during the German advance drifted into the lines of the regiment. The night was very dark and a thick cloud of fog blanketed the ground, making visibility less than 50 yards. So unstable was the situation and so insecure the hastily organized line that soldiers frequently called out to one another from adjacent foxholes to determine if comrades were still there. Sounds of moving tanks could be heard in the direction of the enemy.

During the night a 40-man German patrol came down the railroad track flanking the 2d Battalion position and penetrated, without being noticed, all the way back to the reserve area of the 1st Battalion. (See figure 3.) There Company A fired into the German force almost at body-contact range. After an exchange of hand grenades and much wild firing, the German patrol slipped away into the night. A captured prisoner stated that the mission of the patrol had been to break through and cut the Bastogne-Longvilly highway at Bastogne.

Other German patrols, however, were more successful. During the night they cut the roads leading west from


GERMAN COMPANY
1600, 20 DECEMBER
GERMAN 40-MAN PATROL
NIGHT 19-20 DECEMBER
GERMAN BATTALION
PLUS SIX TANK AND TWO S.P.
DAYLIGHT 20 DECEMBER
BIZORY
530
510
501
TO LONGVILLY—2 MILES
TO ALLERBORN—3 MILES
MAGERET
GERMAN COLUMN
1900, 20 DECEMBER
NEFFE
BASTOGNE
MONT
CREEK
REPULSED AT
2300, 20 DECEMBER
2 GERMAN BATTALIONS
AND FIVE TANKS
1900, 20 DECEMBER
TO WILTZ
GERMAN ATTACKS ON
20 DECEMBER 1944
GERMAN ATTACKS
GERMAN 40-MAN PATROL
FRONT LINES
SCALE
1000 0 1000
YARDS

Map 3.

Bastogne and the division axis of communication was severed. The entire medical installation of the 101st Airborne Division was captured and all patients and transportation disappeared.

Substantial armored reinforcements were received during the night. The 2d Platoon, Company B, 705th Tank Destroyer Battalion, arrived and was attached to the 2d Battalion. At the same time the 3d Platoon, Company B, 705th Tank Destroyer Battalion was attached to the 3d Battalion and went into position along a sunken road facing the plain toward Neffe. Moreover, seven tanks from the 9th Armored Division infiltrated into the lines and attached themselves to the 2d Battalion.

To give the division picture for 19 December, the 101st Airborne Division was disposed with its four regiments in a perimeter defense of Bastogne. The dispositions had been hastily made and consequently were loosely organized. There was little or no physical contact between regiments.

THE DEFENSE OF BASTOGNE

On 20 December the Germans made three determined efforts to dislodge the 501st Parachute Infantry from its position astride the principal road leading into Bastogne from the east. Fortunately, each of these efforts was localized and was executed as a separate action. Between each attack the regiment was able to regroup and concentrate its undivided attention on the particular area threatened.

In front of the 2d Battalion position was a broad expanse of farm land which gradually sloped down toward the Neffe-Bizory Road and gradually rose again to the crest of Hill 510. Shortly after dawn the battalion was alerted by the sound of tanks moving in the vicinity of Hill 510. Because of the fog hovering close to the ground in the intervening valley it was impossible to observe beyond 800 yards to the front. All of division artillery was called upon to fire unobserved fire on the crest and slopes of Hill 510. The platoon of tank destroyers trained their guns in the direction of the sound of the armor and the seven tanks from the 9th Armored Division moved into positions where they could fire directly across the valley.

Approximately one hour elapsed before a German column came into sight. Heading straight across the valley were six Mark IV tanks and two self-propelled guns followed by what appeared to be a battalion of infantry in deployed formation. At once firing broke out all along the battalion front. The tanks and tank destroyers engaged the German tanks at 700 yards registering direct hits on two of them and knocking them out. In the exchange one of the tank destroyers was hit and another tank destroyer was damaged in changing positions.

Within 300 yards of the main line of resistance the advancing infantry wave broke. The German infantry withdrew and the German tanks soon followed suit, veering off to the north. When the smoke finally cleared the charred or burning hulks of five German tanks were seen on the battlefield.

It started to snow around noon. The snow fell so rapidly that within an hour the countryside was white. The men lined their foxholes with straw, and wore every garment that could be found to keep them warm.

Throughout the day the Germans shelled Bastogne. Hardest hit was the regimental command post. The monastery in which it was established was in plain view of the enemy from Hill 510. The belfry of the monastery, silhouetted against the skyline, made an excellent artillery registration check point and the enemy artillery took the maximum advantage of it. Enemy tanks on Hill 510 also shelled the command post with direct fire, forcing the personnel to move to the cellar.

The regimental commander attached Company A—the reserve company of the 1st Battalion—to the 2d Battalion. The mission assigned the company was to move through some patches of woods near the railroad track running along the regimental north flank, clear any enemy which might be in the woods, and close the regimental north flank to the line of the railroad track. (See figure 3.) This maneuver was designed to close the gap between the 501st and 506th Parachute Infantry Regiments by making contact at the railroad.

At 1600 it was still snowing. As twilight closed in Company A was moving through the last patch of woods south of the railroad. A patrol which was preceding the company sighted a German force estimated to be two companies, one moving north of the railroad embankment, and one south of the embankment at a point about 500 yards from the leading elements of Company A. The patrol returned to the company without being detected by the enemy. The commander of Company A ordered the 3d Platoon to move north of the tracks and establish an ambush in a point of woods 150 yards to the north. (See figure 3.) The 1st and 2d Platoons were ordered to deploy on line 100 yards south of and facing the tracks. The railroad track in this area ran along the top of an embankment rising approximately 15 feet from the ground level, dividing the zone of action, in effect, into two separate compartments. The force north of the tracks could not see the force south of the tracks except from the top of the embankment. Neither could influence the action of the other without first crossing the embankment.

The 3d Platoon of Company A fired at close range upon the German column moving north of the tracks. This unexpected fire falling suddenly upon their flanks broke up the enemy column. Some men hit the dirt and sought shelter in the folds of the ground. Others ran for the cover of the woods. Carefully aimed machine gun and rifle fire cut down many of these men as they fled across the open field between the 3d Platoon position and the next woods.

On the south side of the tracks things were not going too well for the 1st and 2d Platoons. About the same time that the firing broke out in the 3d Platoon area, the remainder of the company, under relatively unfavorable circumstances, met the full force of the German column moving south of the tracks. The 2d Platoon was caught in the open and the 1st Platoon, disposed on low ground, was not much better off. The fire fight that ensued cut deeply into the ranks of both the attacker and the defender. The fighting was at close range and neither had the advantage of concealment or cover. As darkness closed in the commander of Company A, feeling that he was opposed by a force far superior to his

own and fearing that he might be outflanked, ordered a general withdrawal to the line of another woods to the south. He instructed the 3d Platoon—on the other side of the embankment—to break contact with the enemy and follow the 1st and 2d Platoons to the designated woods south of the tracks. (See figure 3.)

The withdrawal was executed in an orderly manner and upon reaching the new position the company established a line along the forward edge of the woods facing northeast. Evidently the Germans called a halt to their attack at about the same time, for Company A was not troubled during the night.

The next morning, 21 December, Company A renewed its attack from the woods. Under supporting fire from the 907th Glider Field Artillery Battalion the company attacked on the same ground over which it had retreated the night before. In conjunction with this attack a battalion of the 506th Parachute Infantry attacked south. The enemy, finding himself caught in a pincer movement, withdrew. Thus, after 24 hours of movement and skirmishing, contact was established between the two regiments.

While Company A was engaged with the German force trying to make contact with the 506th Parachute Regiment to the north, the third and most determined German attack of the day (20 December) struck the 501st Parachute Infantry on the south. Beginning at 1900 a heavy artillery concentration lasting for approximately 20 minutes fell all along the line from Bizory south to Mont. The wire lines between battalion and regiment went out almost immediately, placing the burden of communication upon radio. As the artillery lifted and began to fall deeper into Bastogne, a two-pronged attack struck the 1st and 3d Battalion positions almost simultaneously. Illuminating flares from 60-mm mortars revealed a column of German infantry charging straight down the Bastogne-Longvilly Road toward the 1st Battalion and more Germans moving across the open fields toward the 3d Battalion position. (See figure 3.) The final protective fires of the two battalions and the fires of division artillery were brought down along the slopes in front of the position and on the road into Neffe.

In the 1st Battalion sector a platoon of Company B occupied a strong point in a house about 200 yards in front of the line and about 50 yards from the road. The men held their fire until the enemy advancing along the road were abreast of the house. The German infantry was then taken under close-range fire with machine guns and rifles. The German advance along the road was stopped cold.

Meanwhile, the 3d Battalion front was ablaze with tracers and exploding shells. An estimated five German tanks had placed themselves on line and were shelling the battalion from a wooded knoll south of Neffe as two battalions of infantry, attacking in column, advanced across the open fields east of Mont. Division artillery fired in support of the defense, and in some sectors this fire was adjusted to within 100 yards of the front line. The tanks and tank destroyers fired continuously at the enemy tanks.

The battalion north flank along the creek line was forced back, but the center and the southern flank held. A peculiar terrain obstacle doomed the German attack to failure. The five-strand barbed wire fences criss-crossing the fields in rectangular pattern provided an excellent network of protective wire and the German attack piled up on these fences. The defensive fires from infantry, armor, and artillery cut down the German infantry as they attempted to cross the fences. The attack failed and the Germans withdrew.

By 2300 the left flank of the 3d Battalion had been restored and except for the occasional crack of a rifle, the front of the 501st Parachute Infantry was quiet.

After this action the situation along the 501st Parachute Infantry front became stabilized. The German 47th Panzer Corps had attacked from the northeast, east, and southeast and, finding determined resistance at every quarter, abandoned their efforts.

ANALYSIS AND CRITICISM

Units that have been withdrawn from the line for temporary periods of rest must be prepared at all time to be committed to combat—regardless of their reserve status. Lack

of adequate winter clothing, combat equipment, and weapons materially reduced the combat effectiveness of the 101st Airborne Division. When the 1st Battalion encountered the enemy at Neffe, those men who were lacking weapons, steel helmets, and adequate combat equipment were sent to the rear and remained with the rear command post until weapons and helmets could be collected from retreating stragglers. In the initial engagement this represented a loss to the regiment of approximately 125 men—more than the strength of one normal rifle company of the regiment at that time.

Warning orders should be clear and should give sufficient information to permit early planning. Vague, incomplete, and fragmentary instructions impair efficiency and jeopardize the chances for success. The initial orders designating the 101st Airborne Division's movement failed to give the correct destination. Fortunately, this error was corrected before any material harm was done.

A thorough understanding of the situation is vital to an organization moving in to operate in an unfamiliar area. No information of the existing situation was available to the 501st Regiment for the move to Bastogne or for the movement to contact on 19 December.

Adequate provisions for traffic control must be made if battlefield mobility is to be achieved. An effective plan for traffic control would have prevented the traffic congestion on the Bastogne highway. The traffic jam delayed the movement from two to five hours at a very critical time and actually prevented some units from taking part in the engagement.

Warfare demands decisive action. To the commander of the 101st Airborne Division the situation at Bastogne was obscure. The employment of the 501st Parachute Infantry to find and fix the enemy was sound in tactical concept; however, the objective assigned the regiment, if secured, would have placed the regiment too far from the remainder of the division. In view of the fact that the underlying motive for the employment of the 501st was to develop the

situation, it is felt that the mission could have been accomplished with far less risk by giving the regiment a series of limited objectives to the east.

It is difficult to predict what course a particular engagement might have taken under different circumstances. At first it might appear that the best course of action for the 101st Airborne Division would have been to go on the defensive; however, in this instance the offensive proved effective in halting the German advance. Lieutenant General Bayerlein, commanding the panzer division, the lead elements of which struck the 501st Regiment on the move to Neffe said, "The movement of the Infantry Regiment which came out of Bastogne to attack me reacted decisively on my thinking." His division recoiled and hesitated and did not launch an attack on Bastogne until the next day. The aggressive mission of the 501st wrested the initiative from the German armored corps.

In a movement to contact, the movement must be covered by a strong reconnaissance screen to the front and the flanks to avoid surprise, to permit flexibility, and to avoid an unfavorable engagement. In the attack made by the 501st Regiment the reconnaissance force designated to move ahead of the regimental column was lost in the traffic jam. Consequently, the regiment proceeded blindly and was forced to deploy in the face of the enemy without benefit of warning or prior planning. Fortunately, the advance guard battalion was moving far enough ahead of the main body so that sufficient maneuver room was available to commit the 2d Battalion under more favorable circumstances.

In a meeting engagement the initial advantage accrues to the commander who is disposed upon the most favorable terrain, and who first initiates plans for rapid entry into combat. Often the issue is decided by the occupation of key terrain and insuring the security of the flanks. Upon meeting the enemy the regimental commander of the 501st Parachute Infantry exercised good judgment and followed sound tactical principles in the commitment of his forces. When contact was made barely four miles from Bastogne, the original objective of the regiment lost its significance. Sensing that he was opposed by a force larger than a mere

road block and feeling keenly the hazard involved in advancing into a German force which was known also to be advancing, the regimental commander seized the best available terrain and proceeded to develop the situation. This action was the initial step in the successful defense of Bastogne.

The advisability of sending Company I on a deep development around the south flank to Wardin is a questionable maneuver. Company I was committed for the dual purpose of performing a reconnaissance of the south flank, about which the regimental commander was vitally concerned, and as a secondary mission, to seize Wardin if the company could do so without becoming too heavily engaged.

After making a successful attack, failure to reorganize on the objective caused disaster. The German counterattack struck while the company was disorganized and improperly disposed for defense. Consequently it was overrun by the weight of the German attack. With consideration for the size of the German force, it is doubtful that Company I would have been able to hold Wardin even under the best of circumstances. Notwithstanding, had the company been organized and under firm control, it probably would have been able to withdraw in reasonably good order.

In an attack in which little or nothing is known of the enemy dispositions, maneuver is conducted aggressively but with methodical security. Had the 501st by-passed the enemy at Neffe, which through maneuver it probably could have done, the regiment might have secured its objective without much difficulty. Such a maneuver, however, would have left the road to Bastogne open to the German columns moving in from the southeast and east.

Reserves add depth to a defensive position and provide a means whereby the commander can influence the action. When night defensive positions were assumed on 19 December, the regiment was committed on an extended frontage. Companies had no support platoons and only the 1st Battalion had a reserve company. Until the arrival late in the evening of 19 December of a Battalion from the 327th Glider Infantry, the only regimental reserve consisted of the remnants of Company I which had been reorganized

under the command of its 1st Sergeant. Because of this situation, two important principles of the defense were violated: there was little flexibility or depth to the position. Yet defensive strength of the terrain and judicious employment of weapons can offset weakness in numbers. The 501st Parachute Infantry was opposed by an overwhelmingly superior force, but through careful selection of key terrain and effective employment of infantry and armored fire power, the Germans were repelled.

In their attacks on 20 December the Germans violated the principle of mass in the employment of their forces. Three separate probing attacks were launched, each on a separate sector of the front and at a different time. The size of the forces involved ranged from a battalion to a regiment. By choosing this method of attack the Germans failed to bring a superior force to bear at any one point on the regimental line. Sufficient time elapsed between attacks to enable the regiment to redispose its forces and to devote its undivided attention to the sector threatened. Concentrated in the Neff-Margeret-Noville area the Germans had two divisions—Panzer Lehr Division and the 26th Volksgrenadier Division, together with supporting Corps troops —sufficient force, if properly employed, to overwhelm the thinly held line at any point.

The attack against the 3d Battalion during the night of 20 December was most unwisely executed. When the initial attack failed, another attack was launched across the same area and was stopped by the same wire barrier and by the same fire.

A significant role was played by the friendly armored units which infiltrated into Bastogne during the night of 19-20 December. The joint infantry-tank and tank destroyer support decided the fate of the German armored attacks on 20 December. Without these reinforcements it is unlikely that the 501st Parachute Infantry could have held its ground against the German armored attacks.

Often seemingly unimportant and relatively isolated engagements can achieve decisive results by the reactions they have on the opposing commander. The enemy commander, mistaking the action of a single rifle company, Company I,

for a much larger force, imagined himself faced with a superior force to his front and at the same time being outflanked by a large force from Wardin. He accordingly called a halt to his advance on 19 December, and, like his opponent decided to develop the situation to his front. This delay doomed the German advance on Bastogne to failure. It provided valuable time for the 501st Parachute Infantry Regiment to get its defensive position consolidated on dominating terrain, where with the aid of armored reinforcements, it repelled the German attacks on 20 December. By holding Bastogne, the hub of a vital road net leading into the Eastern Ardennes was denied to the advancing German columns.

LESSONS

Some lessons emphasized by this operation are:

1. Units that have been withdrawn from the line for temporary periods of rest, regardless of their reserve status, must be prepared at all times for commitment to action.

2. In planning and executing an attack, a thorough understanding of the mission is vital to the success of the mission.

3. In a movement to contact, particularly under conditions of reduced visibility, provisions must be made for a reconnaissance screen to move well in advance of the column and reconnoiter the front and flanks along the axis of advance in order to avoid surprise and to permit flexibility of plans.

4. The advance guard of a regiment moving to the attack should be far enough in advance so that the main body will not unwittingly become involved in the same engagement.

5. Proper evaluation, selection, and utilization of terrain can reduce the effect of incomplete information of the enemy and inferiority in numbers.

6. In a meeting engagement immediate consideration must be given to securing your own flanks and developing the flanks of the enemy and fixing his zone of advance.

7. In a meeting engagement contact with the enemy must be maintained. Aggressive maneuver should be directed toward seizing critical terrain features.

8. A regiment should rarely be assigned an objective beyond the supporting range of the bulk of the division forces.

9. A rifle company should not be employed upon a mission that a patrol could accomplish effectively.

10. Reorganization must be rapid and provisions made for immediate defense of the objective. Troops must not be allowed to loiter.

11. Piecemeal attacks against a strongly-organized position are ineffective, uneconomical, and offer little chance of achieving decisive results.

12. Failure to make provisions for the control of traffic can often adversely effect the tactical plan.

Considerations Governing Operation in Deserts

"The Western Sahara is a place fit only for war," declares the narrator in the British documentary motion picture *Desert Victory*. He might have added that war in the desert involves tremendous difficulties as compared with combat in more temperate areas. Yet the ability to conduct operations in deserts is as essential to the execution of strategy in modern war as in the times of Alexander, Napoleon, Kitchener, and Allenby.

Deserts have military importance because of their geographical position. Although they may not in themselves contain the rich prizes of conquest, they serve as routes of communication between areas of major strategic importance. Deserts of the Middle East not only serve as the traditional land route between the Mediterranean and India, but they are also rich in oil. Deserts, like sea frontiers, separate the spheres of influence of the world's great powers.

There are eight principal desert areas in the world. They lie within two broad belts girdling the earth, between the tropical climate of the Torrid Zone and the Temperate Zone to the north and south (see Figure 1).

First and most commonly known is the mighty *Sahara Desert* in northern Africa, an area of 3½ million square miles, nearly as large as the continent of Europe. It has a great variety of terrain, all with very little vegetation. Most of it is loose shifting sand, but there are large areas of sandstone, limestone, and volcanic rock. It has salt marshes, brackish mudholes, rocky escarpments, wild canyons, and mountains. It is swept by hot, dry winds that frequently cause severe sandstorms. Temperatures are extremely high in daytime—up to 132°F—but drop sharply at night. During the winter months, nights are bitterly cold.

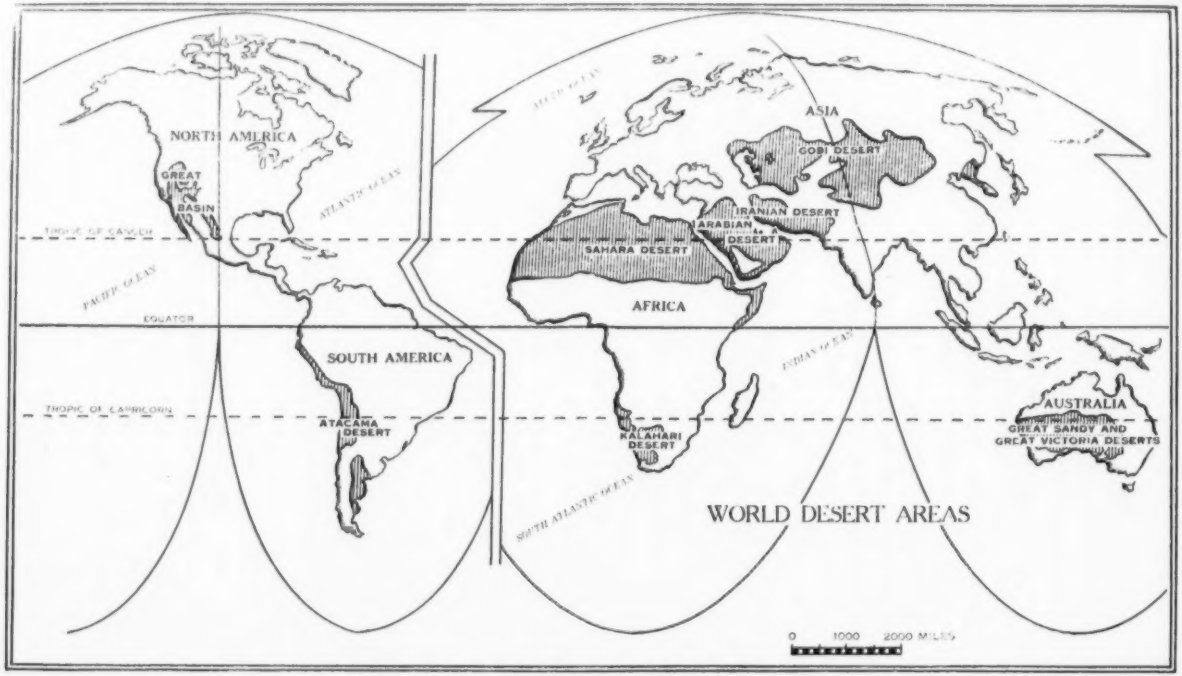


Figure 1. Important desert areas of the world.

The *Arabian Desert* extends over one million square miles of Iraq, in Asia minor. It comes nearest of any large desert area to being a complete sand waste, with great dunes, continuous drifting, and almost no vegetation except at the occasional oasis. The Syrian Desert is an adjoining area to the north, and may be considered part of the Arabian Desert region. It is less barren and less sandy, containing rocky soil and sparse vegetation.

To the northeast of the Arabian Desert, in Asia proper, is the *Persian (Iranian) Desert,* extending from the Persian Gulf to the Caspian Sea. The mean elevation of this region is about 4,000 feet, and the climate is severe. Winters are cold. From May to September great dust storms are frequent. During the "wind of 120 days," sand blows almost continuously from the north, with velocities up to 75 miles per hour. The Persian Gulf Command became familiar with this area during the last war. This desert region extends into India, and into southern Russia. It includes the desolate wasteland along the eastern shores of the Caspian Sea, called the *Kara Kum* ("Black Sands").

The *Gobi Desert,* in China, is a huge waterless area of 600,000 square miles, surrounded by high mountain barriers that cut off rainfall. The area is nearly treeless, but most of it is covered with wiry, tufted grass. The whole area is elevated between 3,000 and 5,000 feet above sea level and has a severe climate, with extreme variations in temperature during a 24-hour period.

In North America, the *Great Basin* contains large areas of desert, aggregating about 200,000 square miles, in Arizona, New Mexico, Nevada, Utah, and parts of Texas, Colorado, California, and Northern Mexico. Much of the terrain is rocky and mountainous, and is cut up by ravines, canyons, and escarpments. Vegetation is sparse, consisting mostly of cactus and sagebrush.

High mountain barriers also deny rainfall to the *Atacama Desert* in Chile, Argentina, and Bolivia. It is mountainous area, at an elevation of 7,000 to 13,000 feet above sea level. The whole area is desolate and barren, and is inhabited only because it is the richest mining area in South America.

The *Kalahari Desert* in the South African highlands consists of great areas of red sand and extensive mud flats. Most of it is covered by a heavy growth of scrub trees.

The eighth important desert area lies in Western Australia, covering approximately 600,000 square miles and including the *Great Sandy* and *Great Victoria Deserts*. The interior of these desert areas is practically uninhabited. Rainfall is erratic, arriving in cloudbursts once or twice a year. Storms and violent cyclones occur frequently. The area is flat and level, with a few small mountains here and there, and contains scrub growth.

Figure 2. Aerial view of a typical desert area in northern China.

PHYSICAL CHARACTERISTICS

From these brief descriptions, it is evident that deserts differ greatly in appearance. In addition to the standard movie version of fine sand, piled in endless dunes under a burning sun, desert terrain varies from flat plains to rugged mountains. Certain physical characteristics can, however, be accepted as generally applicable to all desert areas.

A desert is an arid land, with an average rainfall of less than 10 inches per year. Long periods of drought discourage the growth of vegetation. The scanty rainfall may be received entirely during one short season, in torrential amounts. Rains flow rapidly off the barren soil or are completely absorbed. The *wadis*—stream beds which are dry most of the year—are transformed by sudden flash floods into raging torrents which are lost, farther on, in the sands or in a marsh. Sources of water are few, and usually are polluted and brackish.

Soils, lacking the vegetative cover to resist erosion of wind and water, are generally sandy or rocky. The terrain is mostly open, dry, and firm, with few stream barriers, but there are stretches of deep, soft sand, boulder strewn areas, muddy salt marshes, eroded gullies, and steep outcroppings of rock.

Figure 3. Boulder-strewn areas and rock formations restrict movement in deserts.

Desert areas are characterized by brilliant sunlight and extreme heat during the day, and cold nights. Sharp changes in temperature produce sudden, violent windstorms, carrying dust and sand with blinding force.

Desert areas are sparsely populated. Scarcity of water and vegetation, and the harsh extremes of climate, limit human habitation. Settlements, if any, are widely separated or confined to the fringes of the desert.

MILITARY CHARACTERISTICS

Observation. Open terrain and clear atmosphere offer the prospect of good visibility over long distances in desert areas, but there are other factors which greatly reduce visibility. Brilliant sunlight creates a strong glare as it reflects from the barren soil. An observer with the sun behind him may see very well; an observer looking toward the sun finds his visibility reduced by glare, his depth perception and recognition of objects affected by shadows and haze.

Dust storms sharply curtail the range of observation. Strong winds raise clouds of dust and sand until, at times, aerial observation is impossible, and ground observation is reduced to a hundred yards or less.

Mirages, caused by refraction of light through heated air rising from the extremely hot sandy or stony surface, may greatly reduce observation. Mirage is seen by an observer looking toward the sun, especially during the summer season. Its effect is to distort the shape of objects, particularly the vertical dimension. Shimmering haze, like the familiar "lake" that is seen on a paved highway on hot days, may completely nullify ground observation at a range of five hundred yards or less.

Moonlight is much brighter in desert areas than normal. Nights are usually crystal clear; winds die down; haze and glare are gone. Observation on a moonlit night may be better than during certain periods of the day. Shadows on the light-colored terrain can be seen for miles, although they may appear grotesque, so that the shadow of a sand-dune looks exactly like a tank.

In open terrain, sound and flash ranging are particularly effective. In many areas, ground observers may find few heights from which to get a commanding view of the terrain.

Fields of fire. Because of the scarcity of vegetation in deserts, there is seldom need to clear a field of fire for flat-trajectory weapons. As always, dead spaces exist in even the most level areas. In general, the ability to deliver fire effectively is limited only by the range of weapons and adequacy of observation.

Figure 4. A camouflaged gun position in the California desert.

Cover and concealment. Since there is defilade even in level areas, and since deserts include sand dunes, hills, ravines, and even mountains, it may be concluded that desert terrain provides a reasonable amount of cover from hostile fire. Concealment, however, is a far greater problem. Scrubby vegetation does not conceal bodies of troops and

their vehicles and equipment. Troops in the desert for the first time experience a feeling of nakedness—of being unable to hide from enemy observation. This apprehension disappears as men become familiar with the surroundings and develop skill in the technique of improvising concealment. Camouflage is used more extensively than in normal terrain. Nets and other artificial means of camouflage are required, since natural materials are lacking.

Obstacles. Compared to any other type of area, there are relatively few obstacles to movement in the desert. Although there are few roads, vehicles generally can move cross-country at will, unimpeded by vegetation, streams, or soft ground. Areas which restrict movement usually can be by-passed.

Lines of communication. There are few roads and railroads in the desert. The few towns are separated by vast areas of wasteland. Travel in the desert involves great distances. Military forces therefore must operate with long lines of communication. During the North African campaign in the last war, as the British moved west from their Egyptian bases, their supply problems increased until eventually they were unable to properly maintain their forces at the front. The Germans then advanced eastward until, in turn, they were incapable of maintaining their long lines of communication and were forced to halt. Lack of local sources requires the transportation of all supplies, even water, from distant bases.

EFFECT ON TROOPS AND EQUIPMENT

Water discipline. Scarcity of water has always limited military operations in deserts. Even today, the size of forces employed and the extent of operations depends upon the ability to supply water, by vehicles, pipe-line, or other means. Commanders must keep two opposing factors in balance: first, troops operating in desert heat require considerable amounts of water to survive; second, supply of water in adequate quantities is a difficult logistical problem.

The need for water must be satisfied or combat effectiveness is lost. Even inactive troops, dug into sand which may

reach a temperature of 170° in the burning sun, perspire intensley in order to maintain a normal body temperature. Thirst and dehydration lead to heat exhaustion.

The problem of water supply is reduced by training in water conservation and control over the rate of consumption when necessary. Well disciplined troops can operate efficiently on a rationed amount of water by learning how to get the most benefit out of their daily allotment, for drinking and for personal cleanliness as well.

Avoidance of unnecessary exertion, and planning heavy work so it can be done at night or during early morning hours, will reduce discomfort from thirst. Long foot marches during the heat of the day are avoided.

Health and sanitation. Scarcity of water for bathing and laundering creates special problems in sanitation. Perspiration and the ever present dust or sand combine to produce sores and skin infections. Troops must keep clean. A sponge-bath can be taken with only a small amount of water. Air and sunlight help to purify clothing and bedding when there is no water for laundering.

Protective measures are taken to prevent sicknesses and diseases common to the desert climate. The head, eyes, and neck are kept covered against the bright sun. All local water is almost certainly contaminated, until properly purified for drinking. Foods are handled so as to avoid contamination and spoilage. Foodstuffs obtained from natives are likely causes of sickness. Undue exposure to insects is avoided, because of the prevalence of sand-fly fever and similar diseases in desert areas. Proper disposal of body wastes is a safeguard against the spread of intestinal infections.

Current development projects for future desert operations include portable field equipment for water purification, refrigeration, and laundry.

Clothing. The same light-weight clothing worn by troops in any warm summer climate is suitable for wear in the desert. Experiments and research continue to be directed at increasing the comfort of the uniform, and at the same time

protecting the wearer from the direct rays of the sun, insects, and the abrasive effect of rocks and sand. Cold nights make it necessary for troops to have extra clothing and blankets, even in summer.

Vehicles and weapons. Distance and the rigorous climate limit the effectiveness of the foot soldier in the desert. Ground operations are dependent on the mobility of vehicles. Heat, dust, and cross-country movement impose special maintenance problems. Water-cooled engines are equipped with condensers to recapture steam from the radiator. Sand and dust must be frequently cleaned from carburators, fuel lines, and lubricating systems. Oil filters are inspected daily.

Figure 5. M29C Cargo Carriers (Weasels) undergoing tests by Task Force Furnace, Arizona desert, 1947.

Tracked vehicles operate with little difficulty over desert terrain. Wheeled vehicles are also operated successfully despite certain difficulties. Low-pressure balloon tires give

better flotation and traction in sand than the heavy rib-tread of standard military tires. Life of tires is short, due to the heat and the abrasive action of sand and rocks. Life of springs, axles, and power trains is shortened by operation over rough stony ground. Driver training in proper cross-country operation counteracts these conditions.

Dust and extreme heat may seriously impair the efficiency of crews operating track-laying vehicles. During the last war, air conditioned tanks were developed and used in the desert.

Maintenance, battlefield recovery, and salvage are intensified in desert operations. Early in the North African campaign, the equipment of several British armored divisions deteriorated so rapidly, because of mechanical failures, that the entire divisions had to be withdrawn from combat after only two months and refitted.

All weapons require frequent cleaning and lubrication and the habitual use of protective covers to keep out dust and sand.

TACTICAL OPERATIONS

Movement. Desert warfare is characterized by freedom of movement. Historical accounts contain many examples of spectacular maneuver of highly mobile forces. Motorization has put an end to the static defense of fixed posts. Mobile units are no longer so closely limited by sources of water, and have a wide radius of action. Bases are widely separated. Mobile units maneuver in columns with open flanks. Thus, desert warfare has the characteristics of naval warfare. Ultimate success lies with the force able to maneuver with the greatest speed and flexibility. Air transportability of units and supplies assumes increased importance.

Armored forces play the dominant role, because in desert warfare a premium is placed on the well-known capabilities of armor: speed, shock action, and fire power. The principles of tank-infantry employment are unchanged. Infantry must have increased mobility, in order to participate in rapid maneuver with armor and be on hand to consolidate

the seizure of objectives. Therefore, infantry is motorized so that it will arrive at the point of contact on time and in condition to fight.

Ability to maneuver freely favors the use of wide envelopments, turning movements, and operations to cut the enemy line of communication, in cooperation with combat aviation. Essential bases and communication centers in rear areas are vulnerable to bold raids. In the vastness of the desert, raiding forces can escape notice by moving at night, hiding themselves by day, and remaining off the usual routes of travel until they are in position to strike.

Even in the desert, envelopment is not always practicable. Frontal attack may be unavoidable when the hostile force rests its flanks on impassable terrain barriers. Reduction of a fortified position in the desert usually must begin with a penetration, as in any other terrain.

Long movements over the trackless desert, with poor maps and few landmarks, requires the use of dead-reckoning navigation. The method is simple, but highly important. Using a sun-compass or magnetic compass and a vehicle speedometer, a record is kept of the direction and distance traveled from a known point. This information, plotted on the map, gives the approximate location.

Mass and economy of force. Freedom of movement in the desert permits application of the principles of mass and economy of force to the highest degree. It has been said that "The desert is the tactician's paradise, but is hell for the G-4!" Mobile forces are held within supporting distances of lightly held positions. In offensive action, secondary attacks and demonstrations are used to set the stage for a powerful thrust by the major part of the force. Control is highly centralized, and stress is placed on good communication to achieve greater flexibility in dispositions and maneuver.

Objectives. Possession of commanding high ground is a tactical asset in any terrain, including deserts. However, the selection of objectives is not so closely associated with the terrain in desert operations, where the character of engagements is fluid and forces maneuver over a wide area.

Capture of a certain piece of ground may contribute little or nothing to attainment of the ultimate objective—the destruction of the hostile force. Success in disrupting enemy supply lines, denying his sources of food, fuel, ammunition, and water, will impair his ability to maneuver. Having thus gained the advantage in mobility, it is possible to close with the enemy and achieve a decisive result. Sources of water influence the selection of objectives in the desert, for the ability to capture and hold such critical points denies them to the enemy and facilitates further operations.

Security Bold movements of forces with open flanks, over wide expanses of desert are accompanied by the element of risk. Security must be all around, guarding against surprise in all situations, moving or halted, day or night. Security measures take into account the mobility of hostile armor and aircraft and their capabilities to strike swiftly and in strength.

Aerial reconnaissance and distant ground reconnaissance are employed to locate and give warning of the presence of enemy forces. Once contact is gained, vigorous and aggressive patrolling is continued to keep track of the enemy and to form a counter-reconnaissance screen. Reconnaissance to the flanks is intensified to guard against hostile enveloping action.

Moving columns and bivouacs are prepared for all-around defense against ground and air attack. Large columns are given air cover by fighter aircraft, and are reinforced with antiaircraft units. Dispersion is stressed during all movements and halts. The formation adopted permits facing about to fight in any direction. Armored vehicles, antitank and antiaircraft guns, and motorized infantry are disposed to the front, flanks, and rear. Within their protective perimeter move the reserves, artillery, service troops, and supply trains. Such a column can halt and go into a properly secured bivouac without changing formation.

Bases and supply lines are vulnerable to attack. Self-sufficiency of the maneuvering columns, and provision for delivery of supplies by air reduce the drain on combat strength which would be required to provide adequate security for the line of communication.

Surprise. Despite the lack of concealment and the extensive use of air observation, desert warfare presents great opportunities to take advantage of surprise. Deception in the form of decoy movements, dummy positions, feints, and other ruses may be employed. Dummy radio nets may be established. Simultaneously, the real positions are painstakingly camouflaged, and the important movements are concealed by darkness, storms, and radio silence.

Figure 8. Dependable radio communication is vital to successful operation of reconnaissance and security patrols.

Air superiority helps to gain surprise, although it does not prevent enemy reconnaissance aircraft from slipping through. Speed of maneuver behind aggressive counter-reconnaissance forces is used to conceal the striking point of the maneuver.

A surprise attack may be launched by moving into attack positions during a dust storm. Control of movement and of supporting fires becomes so difficult, however, that the

actual attack is not launched until the dust storm ends, except in the case of small raids or other limited operations. An attack timed so that the sun is behind the attacker gives him a distinct advantage.

Night movement and night attack are used extensively in deserts. Moving columns raise great clouds of dust and are easily detected by day. For secrecy, columns may move only at night and occupy camouflaged bivouacs by day. On a bright moonlit night, in order to launch a surprise attack, it may be necessary to complete movement to the line of departure before moonrise. Visibility on moonlit nights is frequently good enough to permit successful employment of tanks and use of maneuver.

CONCLUSIONS

In summarizing the considerations governing desert combat certain conclusions stand out:

Great distances and the importance of movement in desert operations call for maximum endurance of troops and equipment, and ability to maintain high combat efficency under conditions of extreme climate.

All troops employed in the desert must have high mobility under desert conditions, the self-sufficiency to operate at long distances from fixed bases, and the ability to achieve teamwork despite wide dispersion.

Armored units and motorized infantry, with their supporting arms, form the fighting team best adapted to the conditions of desert operations. Ground and air units must be able to cooperate closely.

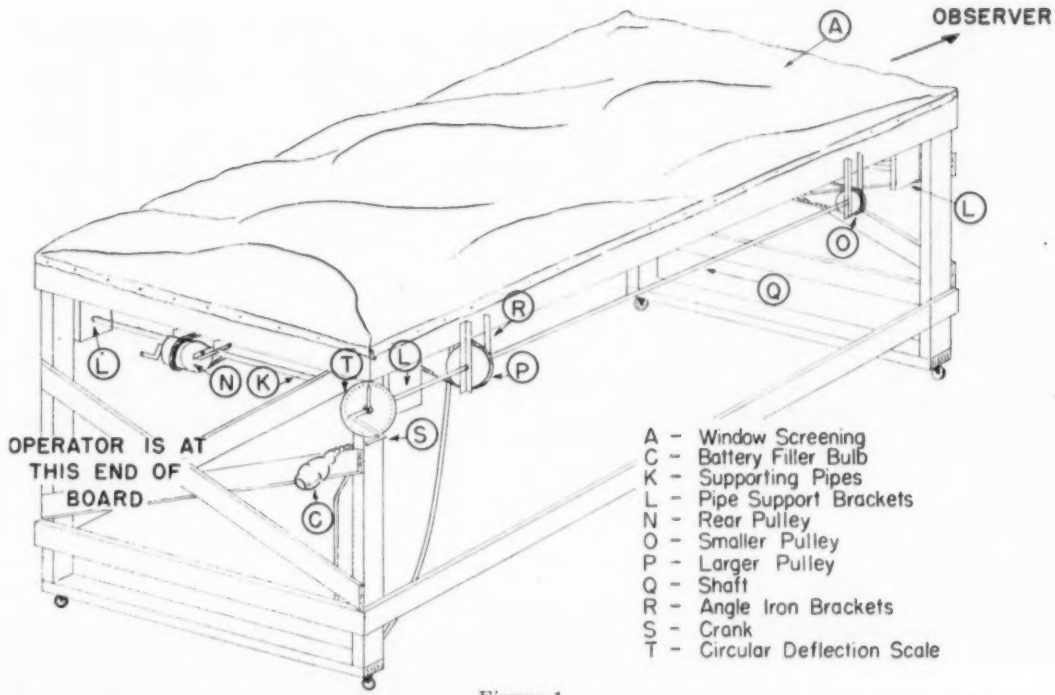
Desert warfare is characterized by the free maneuver of mobile forces. This increases the opportunity to surprise the enemy; at the same time it requires vigilant and continuous security against enemy action. The victorious commander in the desert combines daring and boldness with sound judgement and careful calculation of risks.

The Construction and Use of a Puffboard Trainer

A puffboard is a training aid which is designed to teach individuals the fundamentals of adjusting observed fires. It can be used for teaching direct or indirect fire. This training aid can be used either indoors or outdoors; however, it is best suited for indoor use. If it is mounted on casters or built of plywood, it can be moved about freely and used at the most convenient place.

The primary advantage of a puffboard is that it is relatively inexpensive and can be built by an amateur carpenter. The material can be procured from a lumber salvage yard or can be purchased at a reasonable cost. Experience indicates that one man with a general knowledge of working tools can construct a single board in approximately 30 hours. Duplicate boards can be constructed in approximately half this time by the same individual.

The puffboard offers several advantages over scale terrain boards, gridded devices, or similar training aids. In the first place, the puff of smoke actually has the same characteristics as a puff of smoke from an exploding shell. Because it is visible for only a few seconds, the observer must make his sensing without having the advantage of seeing a marker placed on the board to simulate the bursting shell. Second, it provides an opportunity to train a number of individuals at the same time. In observed fire procedure, for example, the observer and the computer representing the fire direction center are both receiving training simultaneously. Third, the puff-board trainer is scaled so that each puff of smoke is actually plotted according to the observer's fire command; thus it represents the actual change from the preceding round. Fourth, it induces a great deal of realism into training.


OBSERVER
A
L
O
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R
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T
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N
K
S
C
OPERATOR IS AT THIS END OF BOARD
A - Window Screening
C - Battery Filler Bulb
K - Supporting Pipes
L - Pipe Support Brackets
N - Rear Pulley
O - Smaller Pulley
P - Larger Pulley
Q - Shaft
R - Angle Iron Brackets
S - Crank
T - Circular Deflection Scale

Figure 1.

At many military stations actual ranges are available only during certain periods of the year, in some cases for only a few weeks a year. Even when a unit does have a range available, training of observers is limited by ammunition allowances. In order to take the maximum advantage of the use of ranges and the maximum advantage of the ammunition alloted for practice firing, personnel can be taught the fundamentals of bracketing adjustment and can be checked for proficiency prior to being given an opportunity to expend service ammunition.

CONSTRUCTION OF THE PUFFBOARD

The puffboard can be constructed to any convenient scale. The board described here is built to a scale of 1 inch equals 10 yards (1:360). Using a board of this size, one observer can take the actual training and four other individuals can observe and check as he goes through the procedure. A group of 15 to 20 can profit by watching the entire procedure from bleachers or other elevated seats. For a large group or class, a larger board is desirable.

The base of the board is a frame 10 feet long and 5 feet wide. The terrain is represented by ordinary window screening which covers the entire frame (A, Figure 1). The screen is not stretched tightly but is nailed loosely to the frame so that terrain features can be formed by molding the screen with the hands. The screen is painted with a nonglossy paint. Care is exercised to prevent clogging the holes with paint because the puff of smoke representing the burst must come up through the holes. Different colors of paint are used to represent fields, woods, roads, orchards, or other terrain features. Black paint or some paint that shows up with a high degree of contrast is used for roads. Man made features, such as houses, bridges, and buildings may be constructed to scale to add realism.

Four legs are attached to the frame holding the screen. These legs are of such length that the front edge of the board is 4 feet from floor level and the rear edge is 5 feet from floor level. This is necessary in order to give the observer a position which will command a view of the

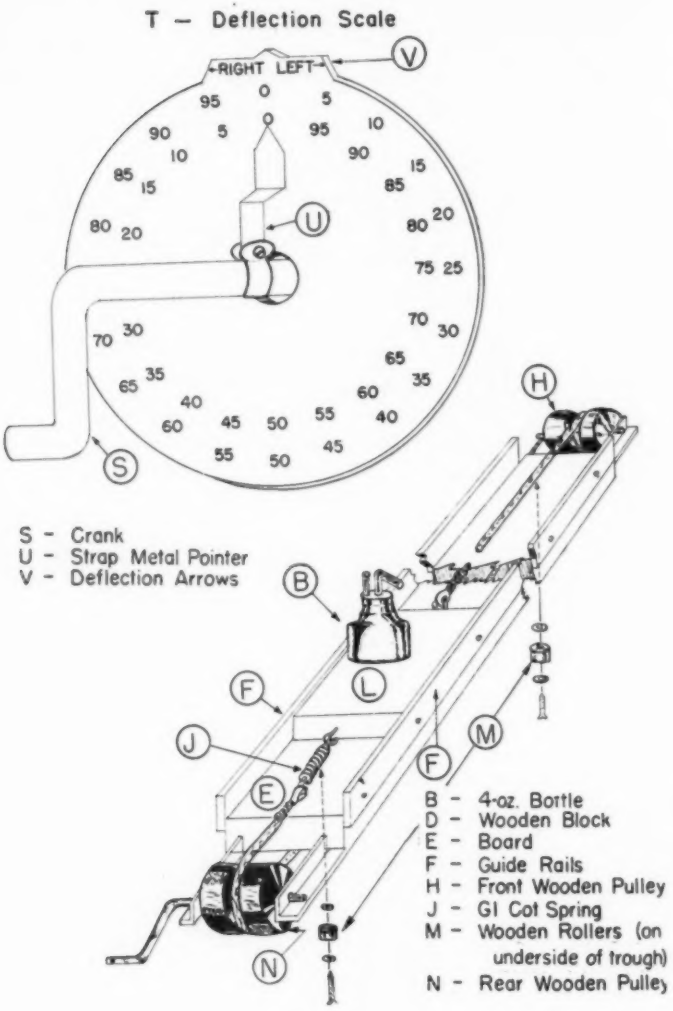

T — Deflection Scale
RIGHT LEFT
0
95
5
90
10
85
15
80
20
75
25
70
30
65
35
60
40
55
45
50
S - Crank
U - Strap Metal Pointer
V - Deflection Arrows
B - 4-oz. Bottle
D - Wooden Block
E - Board
F - Guide Rails
H - Front Wooden Pulley
J - GI Cot Spring
M - Wooden Rollers (on underside of trough)
N - Rear Wooden Pulley

Figure 2.

target area. The legs are braced with cross members as shown in Figure 1. Casters are fixed to the legs if it is desired to make the board movable.

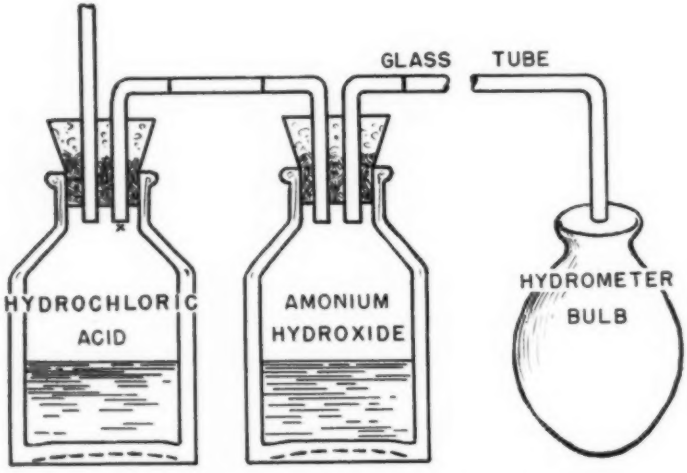
The puff mechanism is a bottle of FS smoke mounted in a block of wood (B, Figure 2. See also, Figure 3.) This block slides along a board which runs the entire length of the puff board (E, Figure 2). Guide rails nailed to either side of the board form a trough which keeps the smoke bottle and the wood block on the long board. Wooden pulleys (N and H, Figure 2) are mounted by angle-iron bracket to each end of the trough. A crank is attached to the rear pulley (N, Figure 2) by a set screw. The front pulley is mounted to the angle-iron bracket by an iron rod.

Clothes line or sash cord fastened to the ends of the block containing the smoke bottle, is used to complete a rope circuit between the two pulleys. A coil spring, such as a GI cot spring, is inserted (J, Figure 2) to maintain tension so that when the crank is turned the puff mechanism slides along the trough. The rope is marked at 10-inch intervals (10 inches equal 100 yards) by rings painted around the rope or by colored strings threaded through the rope. Additional markings of different colors are made for 50 and 25 yard range changes. By turning the crank and watching the markings on the rope the operator can make precise range changes as ordered by the observer or the computer.

The trough which contains the puff mechanism rests freely on two iron pipes (K, figure 1) which are attached to the frame by brackets (L, Figure 1). To prevent the trough from sliding off the pipe and at the same time permit free lateral movement of the trough, wooden rollers (M, Figure 2) are attached to the under side of the trough at each end. These rollers bear against each pipe and are positioned so that the rear pulley (N, Figures 1 and 2) extends beyond the rear edge of the frame. The front pulley is contained within the frame. The position of the pipes and the puff mechanism is planned so that the smoke bottle can move freely under the screen.

The mechanism for controlling deflection must be planned mathematically. Since the board is 10 feet long and it

is assumed that the guns are 100 inches (1,000 yards) behind the forward edge of the board, the puff board represents ranges of 1,000 to 2,200 yards. At the forward end of the board a 10-mil change represents a 10-yard change on the board (10 mils = 10 yards at a range of 1,000 yards). At the rear end of the board, however, a 10-mil change represents a change of 22 yards on the puff board (10 mils = 22 yards at a range of 2,200 yards). Consequently, the deflection mechanism is constructed so that the front and the rear end of the wooden trough move different distances to correspond to mil changes. This will limit some-



NOTE: DO NOT PUT MORE THAN ONE-FOURTH OF AN INCH OF EITHER CHEMICAL IN THE BOTTLES AT A TIME. CHANGE THE HCL FREQUENTLY AND KEEP THE HCL BOTTLE TIGHTLY CORKED WHEN NOT IN USE. THE TUBE MARKED "X" WILL BECOME CLOSED WITH PERCIPITATE FREQUENTLY. ESPECIALLY IF THE OPERATOR MOVES THE UNIT JERKILY CAUSING THE LIQUID TO SPLASH AROUND.

Figure 3. In the event FS smoke is not obtainable from local sources, a two-bottle arrangement can be substituted. The chemical in the bottle on the left is hydrochloric acid; the bottle on the right contains amonium hydroxide. Both are available commercially. When connected in the manner illustrated, a puff of smoke is emitted whenever the rubber bulb is squeezed.

what the amount of usable space on the puff board. Looking from the rear the usable space will appear to be a segment somewhat like the upper half of a large piece of pie. This, however, is only a very slight limitation. The deflection mechanism is properly controlled by the location of two deflection pulleys (O, and P, Figure 1) and by computing the circumference of these pulleys. The two pulleys are mounted on a common shaft (Q, Figure 1). Through two rope circuits which operate from the same hand crank, these pulleys move the puff mechanism, and consequently, the burst, in deflection. The pulleys are fixed to a shaft which is bent to form a crank at the end (S, Figures 1 and 2). Turning the crank rotates both pulleys at the same time.

On the board illustrated in Figure 1 the smaller pulley (O, Figure 1) is located on the 1,200-yard line or 20 inches from the front of the board. The larger or rear pulley (P, Figure 1) is located on the 2,000-yard line or 20 inches from the rear of the board. With the pulleys so located and using the scale of 1 inch equals 10 yards, the smaller front pulley must have a circumference of 12 inches and the larger rear pulley a circumference of 20 inches in order to obtain a lateral movement of 100 mils for each complete rotation of the pulleys. (The diameter of a 12-inch circumference pulley is 3.82 inches; the diameter of a 20-inch circumference pulley is 6.36 inches.) The idler pulleys on the opposite sides of the frame can be of any convenient size.

A circular deflection scale (T, Figures 1 and 2) is mounted over the shaft (Q, Figure 1). It is graduated in 20 divisions each representing 5 mils; it can be graduated in 1-mil divisions. A pointer (U, Figure 2) is made of thin strap metal and fastened to the shaft with a bolt and wing-nut arrangement so that it can be set to zero at the start of each problem. Using this scale, the operator can move the burst in deflection as ordered by the observer. Since the operator faces the observer (Figure 4) and his directions are reversed, he tends to give opposite movements. This is avoided by direction arrows (V, Figure 2) and duplicate scales on the pulley.

The sides of the frame are enclosed to prevent excessive light and wind from affecting visibility. The observer

should not be able to see the puff mechanism through the screen. If excessive light does permit him to see this mechanism, it is necessary to place screens around the board to shut off the view.

CONDUCT OF A DIRECT FIRE EXERCISE

Equipment and personnel required :

Instructor (officer or noncommissioned officer)
Student (forward observer) : binoculars
Recorder (enlisted man)
Puffboard operator (enlisted man)

Procedure: The instructor gives the initial situation, points out the target, and supervises the conduct of the problem. Figure 4 shows a set up where the observer is adjusting direct fire from the gun position (simulating a crew commander in a tank turret). Other situations can be arranged. In this exercise the observer, after identifying the target, issues his initial fire command, senses the burst, issues subsequent fire commands, and continues firing until the mission is accomplished.

Figure 4.

INITIAL FIRE COMMAND:
GUNNER
FIRE MISSION
HE
FRONT
MACHINE GUN
1600
FIRE

ROUND	SENSING	SUBSEQUENT COMMANDS
1	R 20+	LEFT 20, DROP 400, FIRE
2	L S −	RIGHT 5, ADD 200, FIRE
3	+	DROP 100, FIRE
4	−	ADD 50, FIRE
5	+	DROP 25, FIRE
6	T	REPEAT RANGE, 3 ROUNDS, FIRE MISSION ACCOMPLISHED
7		
8		
9		
10		
11		
12		

Figure 5.

The operator moves the puff representing the burst in accordance with the observer's commands. His first round is in error a sufficient amount in both range and deflection to force the observer to use proper procedures for adjustment. Prior to each burst, the operator calls ON THE WAY, to alert the observer.

The recorder notes all commands issued by the observer as well as errors in procedure and terminology. He closely follows the conduct of the adjustment so that he can readily reconstruct the entire problem. A lined blackboard (Figure 5) is used by the recorder. The board is placed so that the observer cannot refer to it, since he must learn to shoot without notes.

Actions of personnel during conduct of problem: (See Figure 5)

OBSERVER	*RECORDER*	*OPERATOR*
Gives initial fire command.	Writes fire command on blackboard.	Fires first burst according to observers order.
Senses burst as Right 20, Over; commands, LEFT 20, DROP 400, FIRE	Enters sensing and fire command on board.	Moves burst in accord with observer's command.
Senses Left 5, short: command RIGHT 5, ADD 200, FIRE	Enters sensing and fire command on board.	Moves burst according to observer's command.

Problem continues until the observer hits the target. Figure 5 shows the entries made by the recorder.

CONDUCT OF AN INDIRECT FIRE EXERCISE

This observed fire problem is conducted in accord with the target-grid method of fire adjustment. (See the article beginning on page 5 for details.) Deflection and range bracketing may be used, but it is recommended that personnel be taught the simpler target-grid method.

Equipment and personnel required:

Instructor (officer or noncommissioned officer)
Student (forward observer): binoculars, compass
Student (computer): M-10 Plotting Board
Puffboard operator (enlisted man)

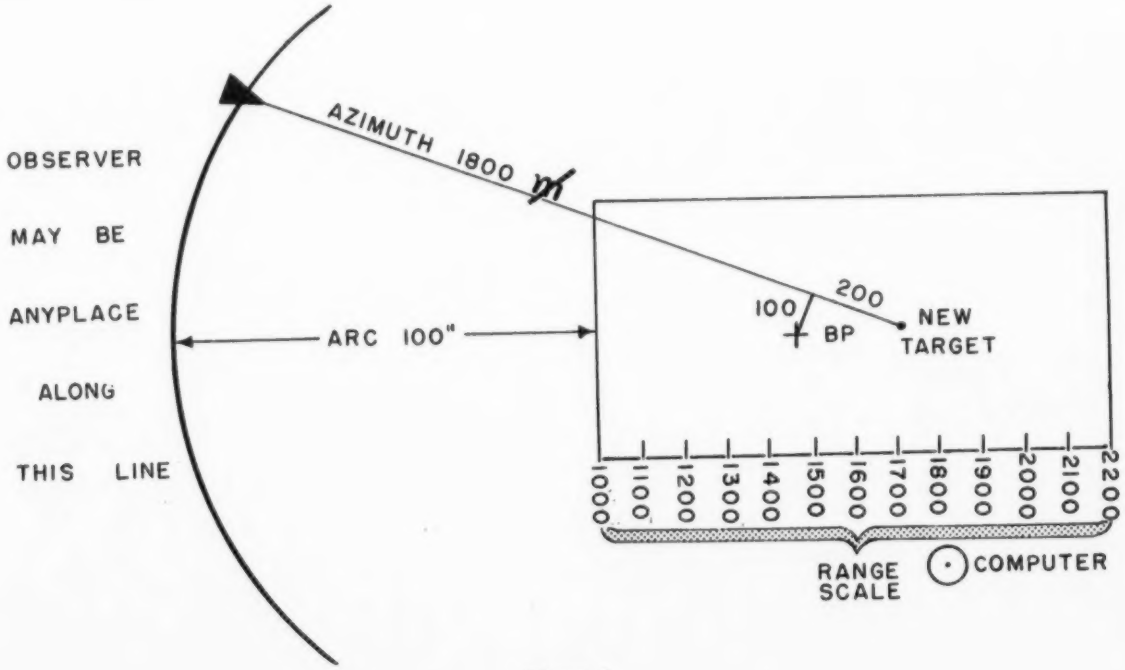

OBSERVER
MAY BE
ANYPLACE
ALONG
THIS LINE
AZIMUTH 1800
ARC 100"
100
200
BP
NEW
TARGET
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
RANGE
SCALE
COMPUTER

Figure 6.

The puffboard is set up under the supervision of the instructor. The observer may be placed any place along the arc (see Figure 6); best training results are obtained when the puffboard is observed from the oblique.

The instructor designates a base point on the puffboard and directs the operator in placing the first burst directly on this point. He gives the computer and the forward observer the following information:

COMPUTER	*FORWARD OBSERVER*
1. Range and azimuth, guns-base point: range 1500 yards, azimuth 1600 mils. (This must be the actual azimuth and the puff-board range.)	1. Designation of the base point. (May be marked by a puff of smoke.) 2. Designation of the target to be engaged.

The instructor supervises the computer's plotting of the base point on the M-10 Plotting Board, and supervises the actions of the forward observer and the computer throughout the problem.

Actions of personnel during the conduct of the problem:

OBSERVER	*COMPUTER*	*PUFFBOARD OPERATOR*
Reads his azimuth to new target and estimates its location from the base point. Sends fire command to computer: FIRE MISSION, AZIMUTH 1800 (mils), FROM BASE POINT, LEFT 100 (yards), ADD 200 (yards), MACHINE GUN, WILL ADJUST.	Orients plotting board on the observer's azimuth and marks the azimuth for future reference; plots the burst from the observer's correction. Sends command to puffboard operator: PLATOON, HE, LEFT 37 (mils), NO 2, ONE ROUND, 1700 (yards), FIRE.	Places the deflection and range on the puffboard and marks the burst.
Senses the burst as left and over; makes the following corrections: RIGHT 25 (yards), DROP 100 (yards).	Orients the plotting board on the observer's azimuth; plots the next burst from observer's correction. Sends command to puff-board operator: RIGHT 3 (mils), 1600 (yards), FIRE.	Places the deflection and range on the puffboard and marks the burst.

OBSERVER	*COMPUTER*	*PUFFBOARD OPERATOR*
Senses burst as short; makes the following correction: ADD 50 (yards).	Plots the next burst in the same manner as above. Command to operator: RIGHT 6 (mils), 1650 (yards), FIRE.	Places the deflection and range on the puffboard and marks the burst.
Senses burst as short makes following correction: ADD 25, FIRE FOR EFFECT.	Plots the next burst. Command to operator: RIGHT 3 (mils), THREE ROUNDS, 1675 (yards), FIRE.	Places the deflection and range on the puffboard and marks the burst.

CRITIQUE

Each problem should end with a critique conducted by the instructor. The critique should be presented in light of the training objective for the exercise. A typical critique might conform to the following outline:

Restatement of the mission. This is a brief summary of the observer's initial situation. It serves to orient all personnel for the critique.

A statement relative to the accomplishment of the mission. The observer and computer are told that they did, or did not, accomplish their mission. If they did, it should be pointed out that they did so by application of proper procedures. If they did not, the critique should show where they failed, and should show how they could have been successful by proper application of procedure.

Highlights of the problem. Here the main points of the problem, both good and bad, are discussed using the recorders notes to reconstruct the problem. Such items as terminology, procedures, wasted time, and wasted ammunition are covered.

Questions and discussion. The observer and computer are given an opportunity to explain and defend their actions. The personnel who only watched are actively brought into the problem. This serves to clear up questionable points and gives the instructor a chance to emphasize and drive home points.

SUMMARY

Careful construction of the puffboard, intelligent planning of exercises, and proper supervision of problems will result in training periods that not only are interesting and beneficial to all participants but which will pay great dividends when the organization moves to the range for service firing. Service ammunition then will be expended to *climax* training and will not be wasted on teaching principles and procedures.

Counterfire Planning and Operation

In World War II it was the experience of the personnel of many front-line units to watch while their assigned objective was deluged by a barrage of fire delivered by all weapons from the company mortars up to include the corps artillery and the tactical Air Force. To the uninitiated it would seem that nothing could survive this blanket of supporting fire. However, a few minutes after crossing the line of departure the assault troops often began suffering casualties from hostile mortars, machine guns, and rifles emplaced in the very area covered by our supporting weapons. It was then necessary for the assaulting troops to advance in the face of this strong hostile fire and accomplish by close combat, a job that might have been done by the support weapons.

The reason for such a situation is certainly not a lack of sufficient fire power. The infantry regiment with its supporting fires is capable of digging out any emplaced enemy. The trouble lies in the fact that a general area coverage by supporting weapons provides only a temporary cease fire period. What must be provided is point designation of targets that will permit destruction of enemy guns and crews, not merely a short-termed neutralization.

The number of casualties resulting from artillery and mortar fragments provided one of the most serious problems for our armed forces. A study of battle casualties by Army Ground Forces revealed that an exceedingly high percentage of casualties resulted from shell fragments as is shown by the following statistics:

Campaign and Unit	*Per Cent*
Saipan (XXIV Corps)	50.7
Okinawa (XXIV Corps)	69.6

Campaign and Unit	*Per Cent*
Anzio (VI Corps)	80.4
Third Army (August-December 1944)	61.3
Fifth Army (January-December 1944)	75.3
Ninth Army (January-April 1945)	64.8

The only known study of the percentage of deaths that resulted from shell fragments was made in Italy. This study indicated that 85 per cent of all battlefield deaths resulted from artillery and mortar fragments. The speedy location and identification of enemy artillery and mortars is of paramount importance in combat. Unceasing effort using all means and methods must be made to provide the information necessary to knock out or neutralize enemy weapons.

COUNTERFIRE INFORMATION SOURCES AND AGENCIES

In order to coordinate counterfire measures in the infantry regiment, the counterfire platoon leader serves as the regimental counterfire officer. He coordinates the employment of all agencies and sources available to the regiment for locating enemy weapons. These agencies include observation posts, aerial observers, front-line patrols, sentinels, supporting artillery facilities, higher, adjacent, and lower units, prisoners of war, civilians, aerial photographs, maps, captured documents, shelling reports, and the sound locating squads of the counterfire platoon. Counterfire measures in the infantry can be successful only if all of these sources and agencies are exploited. Mechanical agencies such as the regimental GR-6 Sound Locating Sets and the radar sets employed by direct support artillery battalions are considered as supplementary agencies only.

Of the preceding sources and agencies, observation is one of the most important. However, in order to produce the maximum results it must be complete and continuous; it must be coordinated; and it must be accomplished by trained personnel. Each agency must provide complete coverage throughout the assigned zone of observation. This includes both shallow and deep areas from which fire can

be delivered on friendly troops. Continuous observation is provided by maintaining OP's regardless of weather or terrain conditions. Personnel used to man observation posts must be thoroughly trained, not only with respect to their ability to observe, but they must be able to report their observations in a concise, specific manner. Observation is coordinated by the assignment of sectors of primary responsibility in order to intensify observation in critical areas and in defiladed areas.

When contact with the enemy has been established, the personnel of front-line units become an excellent source of information. In performing normal duties such as manning a combat outpost or listening post, acting as a security sentinel, or accompanying a patrol, the front-line soldier will be able to report sound, blast, or flash observations of hostile weapons. Although he is usually concerned with other duties when in contact with the enemy, it is imperative that he be trained to report activity of enemy weapons as rapidly as possible. By giving a quick, accurate shelling report, the individual soldier pulls the trigger on a great deal of fire power.

To facilitate timely execution of counterfire missions, all infantry intelligence agencies and the intelligence agencies of supporting arms, particularly the supporting artillery, exchange target information. This procedure insures that each arm is employed according to its capabilities, that unnecessary duplication of missions is avoided, and that missions executed by one arm do not endanger elements of the other. By the same token, the exchange of combat information between the appropriate headquarters must begin on the infantry company-forward artillery observer level, and continue through each echelon of command.

GR-6 SOUND LOCATING SET

Any discussion of infantry counterfire operations must include the GR-6 Sound Locating Set. This set is organic to the counterfire platoon and is the only piece of equipment in the infantry regiment used for the specific purpose of locating enemy weapons. It is desirable to state again,

however, that the GR-6 is a supplementary means; counterfire operations can be successful only if all information collection agencies and sources are utilized to the maximum.

Each of the sound locating squads is equipped with one GR-6 Set. The complete GR-6 Set consists of two microphone arrays of three identical microphones, two sound recording machines, two sound-powered telephone sets, two computers, two aiming circles, two plotting boards, two batteries (power units), and three SCR 300 radios. Thus each squad has equipment to establish two receiving and recording stations. Each set can compute the azimuth to a sound source. Because the two sets are located at opposite

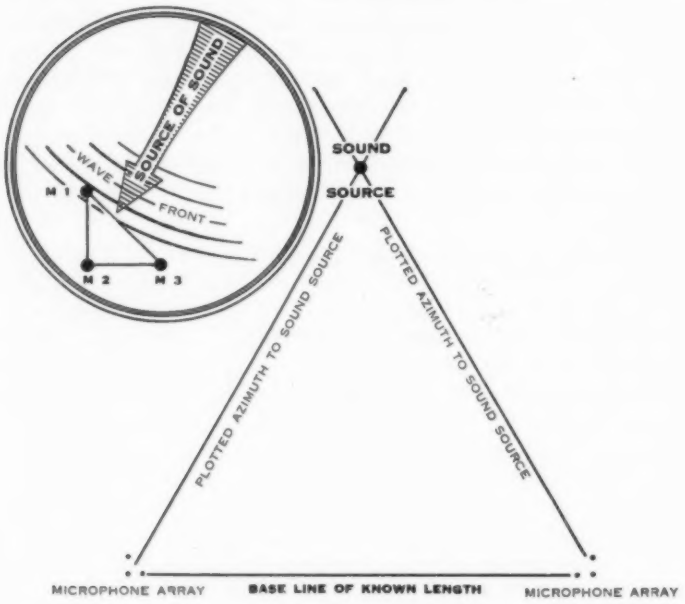


Figure 1. Each of the two microphone arrays of a GR-6 sound locating set determines an azimuth to a sound source. The intersection of the azimuths determines a point location of the sound source.

ends of a base line of known length and azimuth, the intersection of azimuths from the two sets gives a point location of the sound source. (See Figure 1.)

The GR-6 Sound Locating Set has certain limitations. The microphones are able to pick up only those sounds audible to the human ear. Sound waves do not habitually travel in a straight line. They may be deflected or absorbed altogether by woods, hill masses, or buildings. The set itself cannot distinguish between sounds. Climatic conditions effect the efficiency of the set; heavy rain or wind in excess of 18 mph will distort the sound pick-up of the microphone, making it useless as a target locating device.

On the other hand, the set is capable of detecting enemy weapons concealed by camouflage, smoke, fog, darkness, and defilade.

Each of the three GR-6 squads operates as two three-man teams. Each team transports, installs and operates one recorder and microphone array. The squads may be employed singly or together. They are normally employed under regimental control but under exceptional conditions may be attached to an infantry battalion.

REPORTING COUNTERFIRE INFORMATION

A shelling report, commonly called a "shellrep," is used to report counterfire information. These reports are habitually made by troops when subjected to enemy fire or when they can observe hostile weapons activity.

Shellreps furnish extremely valuable information. They are literally the keystone of efficient counterfire operations. In addition to helping locate enemy weapons speedily, shellreps report when enemy weapons are active; indicate new locations of hostile weapons; indicate number, caliber, and type of weapons firing; report effectiveness of enemy firing; indicate zones of fire of enemy weapons; facilitate prompt retaliatory fires; and serve to alert other counterfire agencies.

Every individual should be trained to make shelling reports. The best reports are made by trained men because

they know what type of information is required for counterfire data. (Figure 2). Lack of complete information, however, must not cause delay in its reporting. Often only enough information will be available to permit an individual to report information called for in columns A, C, F, and G. While this information in itself is of little value, if plotted on a map along with other bits of incidental information, it produces an intersection or a triangularized area. Further search of this area may produce an accurate location of an enemy weapon.

INFORMATION REQUIRED IN SHELLING REPORT
(S H E L L R E P)

(a) Who reporting.
(b) Your map location.
(c) Estimated direction of enemy guns by crater, flash, smoke, or sound (tell which).
(d) Estimated distance or location of guns, or angle of fall (average).
(e) Coordinates of area shelled.
(f) Time shelling started.
(g) Time shelling ended.
(h) Number, caliber, and type of guns firing.
(i) Number and type of shells.
(j) Nature of shelling.
(k) Damage.
(l) Flash-bang seconds.

Note. This report is used by individuals and units receiving enemy fire to report counterfire information.

Figure 2.

When shellreps are received at a regiment they are consolidated on a counterfire information form (Figure 3).

COUNTERFIRE INFORMATION

	A	B	C	D	E	F	G	H	I	J	K	L
SHELLREP NUMBER	REPORTED BY & TIME	COORDINATES OF OBSERVERS	AZIMUTH OF SOUND, FLASH, OR FURROW	ESTIMATED DISTANCE OR LOCATION	AREA SHELLED	TIME FROM	TIME TO	NUMBER & TYPE OF GUNS	NUMBER & TYPE OF SHELLS	NATURE OF FIRE	DAMAGE	FLASH-BANG SECONDS (REMARKS)

NOTE: THIS FORM IS USED BY COUNTERFIRE OFFICER TO RECORD COUNTERFIRE INFORMATION.

Figure 3. Counterfire information form.

The entries on this form follow the same sequence as on the shelling report. This form constitutes the regiment's written record of enemy weapons. After a shellrep is recorded in the counterfire information form the information is plotted on the shellrep overlay, suspect overlay, or on the counterfire chart, depending upon the degree of accuracy accorded the report.

PROCESSING COUNTERFIRE INFORMATION

The counterfire chart is a map, preferably to a scale no smaller than 1:25,000. The map itself is covered with acetate. In addition, two single sheets of acetate are fastened to alternate sides of the map board so that they may be

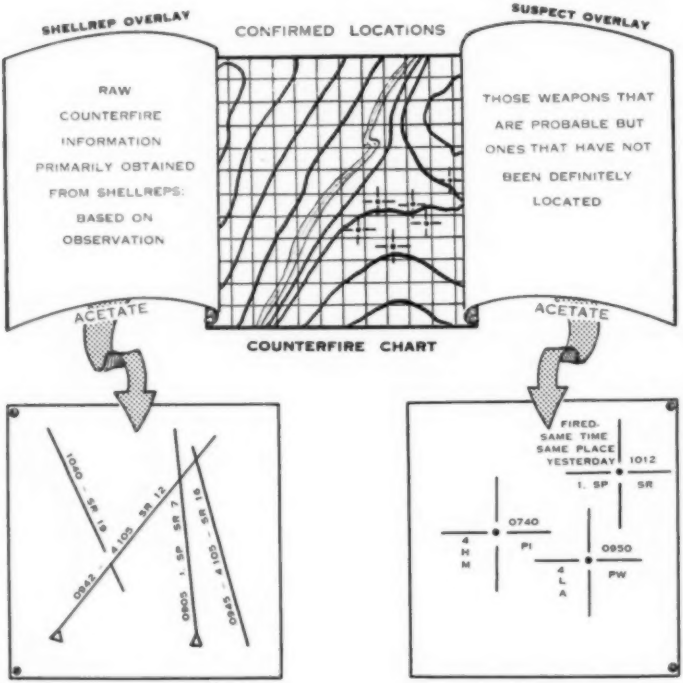


Figure 4. Counterfire chart with shellrep overlay and suspect overlay.

placed over the counterfire chart either individually or collectively. These two pieces of acetate are called the shellrep overlay and the suspect overlay. (See Figure 4.)

Initially, information which has a questionable degree of accuracy or which divulges a minimum of information is plotted on the shellrep overlay. Usually this is information extracted from the counterfire information form.

When such information is received the shellrep overlay is placed next to the counterfire chart and the map location of the observer or shelled area is pin pointed. A plotted ray (colored pencil line, Figure 4) is extended from this point along the azimuth from which the hostile fire was received. The color of the ray may be used to indicate the caliber or type of the reported weapon: blue for mortars, green for artillery, and black for flat trajectory weapons. Other information can be printed along the ray: for example, the time the weapon was reported active, the number and type weapons firing, and the number of the shellrep.

If the flash-bang seconds are reported (column L, Figure 2) on the shellrep, the range from the observers position to the firing weapon can be estimated. This is done by multiplying the number of seconds that elapse between the muzzle flash and the sound of discharge, by the speed of sound (367 yards per second). That is, if four seconds elapse between the time the observer sees the muzzle flash and the time he hears the report of discharge, the range to the firing weapon is 367×4 or 1,468 yards. This range is plotted graphically along the ray, thus giving a tentative map location of the weapon. If a trained observer reports that he has measured the reported azimuth with an instrument, the report may be considered sufficiently accurate to classify as a suspect location. In the event flash-bang time is not reported, the plotted ray shows in graphic form all the available information concerning that particular weapon.

Those plotted intersections which in the judgement of the counterfire officer are logical and reliable are plotted on the suspect overlay. A suspect weapon is one whose

existance and indicated position is probable or highly possible, but which has not been definitely located.

When sufficient evidence of the location of a hostile weapon is accumulated on the shellrep overlay, the suspect overlay is placed over the shellrep overlay. The point of intersection, or center of the triangularized area made by more than two rays, is plotted in the form of a hollow cross (See Figure 5). In the center of the cross is a pin point denoting the weapon location. As in the case of the shelling report overlay, different colored crosses can be used to denote the accuracy of the plotted location: for example, red can denote accuracy within 100 yards, green within 200 yards, blue within 300 yards. Other information is entered in the quadrants of the hollow cross. In the first quadrant (upper right) the last time that the weapon was active is entered. The source of information is entered in the second quadrant (lower right); for example, PW indicates that a prisoner of war has supplied the data. The reported number and caliber of weapons are entered in the third quadrant (lower left). Any other pertinent information is entered in the fourth quadrant. The finished plot then indicates at a glance a suspect location, accuracy of the location, the source from which the location was determined, and the estimated number and caliber of the plotted weapons.

In very slow moving or static situations the mass of enemy weapons, their general location, sectors of fire, and other pertinent information are shown on the suspect overlay. Normally, suspect positions are not taken under fire except in an emergency. Such targets are, however, kept under surveillance by all available agencies. If hostile weapons in a suspect area become active, counterfire missions are executed to attempt neutralization.

When suspect locations are definitely confirmed they are plotted on the counterfire chart. Transfering a plot from the suspect overlay to the counterfire chart is a matter of judgement. If, for example, a hostile mortar battery stops firing whenever counterfire is placed in that area, it is a good indication that a hostile weapons position has been located accurately.

The value of the counterfire chart is obvious. The information on this chart is used when planning for an attack or when planning to neutralize a hostile attack. In other words, it is a method of determining definite areas and targets for support weapons rather than merely issuing orders to "put a little fire on that road, in those woods, and behind that hill."

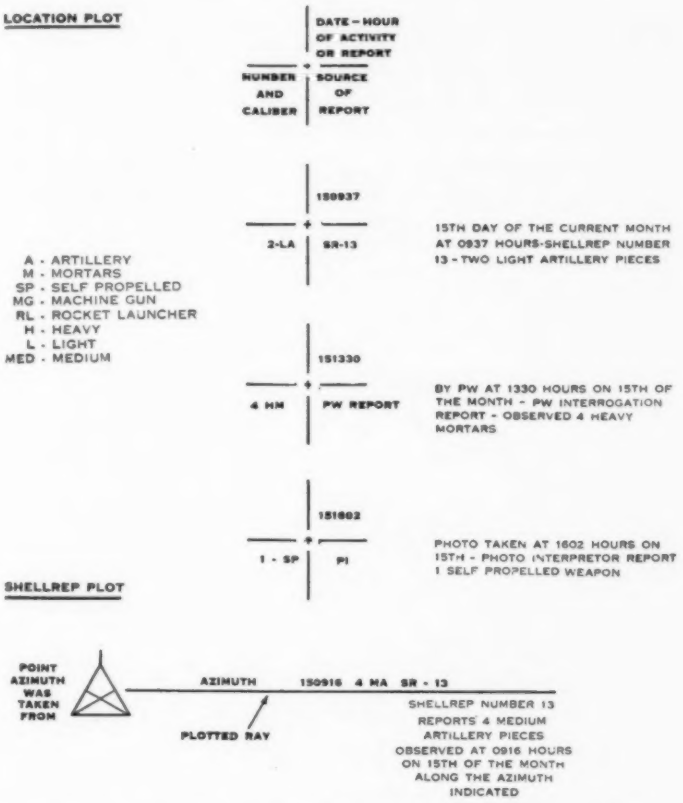

LOCATION PLOT
DATE – HOUR OF ACTIVITY OR REPORT
NUMBER AND CALIBER
SOURCE OF REPORT
150937
2-LA
SR-13
15TH DAY OF THE CURRENT MONTH AT 0937 HOURS-SHELLREP NUMBER 13 - TWO LIGHT ARTILLERY PIECES
A - ARTILLERY
M - MORTARS
SP - SELF PROPELLED
MG - MACHINE GUN
RL - ROCKET LAUNCHER
H - HEAVY
L - LIGHT
MED - MEDIUM
151330
4 HM
PW REPORT
BY PW AT 1330 HOURS ON 15TH OF THE MONTH - PW INTERROGATION REPORT - OBSERVED 4 HEAVY MORTARS
151602
1 - SP
PI
PHOTO TAKEN AT 1602 HOURS ON 15TH - PHOTO INTERPRETOR REPORT 1 SELF PROPELLED WEAPON
SHELLREP PLOT
POINT AZIMUTH WAS TAKEN FROM
AZIMUTH
150916 4 MA SR - 13
PLOTTED RAY
SHELLREP NUMBER 13 REPORTS 4 MEDIUM ARTILLERY PIECES OBSERVED AT 0916 HOURS ON 15TH OF THE MONTH ALONG THE AZIMUTH INDICATED

Figure 5. Plotting symbols for counterfire chart and overlays.

COUNTERFIRE PLANNING

The preparation of a counterfire plan is facilitated by assigning observation areas to subordinate units. This may require division of the regimental sector into two or three subsectors, depending upon the extent of the area. For example, in an assualt situation such as a beachhead or air head, there may be three separate sectors from which current counterfire information will be received. In a situation in which an interior regiment is maintaining frontal contact with the enemy on normal or reduced front, the regimental sector may be broken into two areas of observation for counterfire purposes. These subsectors do not necessarily correspond to battalion areas.

The counterfire plan is based on information and intelligence derived from sources and agencies previously mentioned and from a continuous study of abandoned enemy positions. The study of abandoned positions provides information concerning the probable location of various type enemy weapons used under different tactical situations.

During the preparation for an attack, the counterfire platoon leader concentrates on collecting, recording, and sorting information of enemy weapons activity between the line of departure and the objective. This includes any enemy weapon which might influence the attack and reorganization.

The execution of counterfire missions is subject to the decision of the commander. Factors affecting this decision are: the possible loss of surprise; accuracy of located targets; the fact that weapons employed in a counterfire role will reveal some of their strength and dispositions; and that counterfire may warn the enemy that his weapons have been located, thus giving him a chance to move them to alternate positions. If a decision is made that no counterfire missions are to be fired, a "silent" counterfire policy is in effect. If the decision is made that counterfire missions will be fired, an "active" counterfire policy is announced. Usually neither a purely active or silent policy is in effect, but rather a compromise in which every effort is made to accomplish the destruction of enemy weapons by precision

fire from a single weapon. Once the attack jumps off, however, all known and suspected positions are hit with all available weapons.

To effectively direct and coordinate counterfire measures within the regiment, the counterfire officer initiates either a mobile counterfire plan or a static counterfire plan.

A mobile counterfire plan is put into effect in any situation in which our own troops are either advancing or are executing a retrograde movement. In preparing a single phase of the mobile counterfire plan, the counterfire missions developed from one or more sources are thoroughly planned and ready for execution prior to the arrival of the regiment in the area. This planning facilitates rapid delivery of effective counterfire on active enemy weapons.

The static counterfire plan is prepared in a defensive situation. The difference between the static and mobile plans is that during a static situation a greater number of sources and agencies can be utilized to collect counterfire information. Also, all counterfire installations are more deliberate. Observation posts are accurately located, the counterfire squads and regimental counterfire weapons are surveyed with respect to one another, and where time permits, the survey is tied in with that of the supporting artillery.

Much of the success of regimental counterfire operations depends on proper utilization of the counterfire plans. These plans are based on the assumption that regimental commanders know where the regiment is expected to be five to ten days in advance and what their probable objective will be. It is realized that regiments, divisions, and larger tactical units are subject to frequent lateral displacements. However, in most such situations there is usually a relief effected by one unit for another. If the counterfire officer has done his job properly, he will be able to turn over to the relieving regiment a counterfire plan that can be utilized to continue neutralization of enemy weapons in that particular area.

COUNTERFIRE WEAPONS

Another important duty of the counterfire officer is to coordinate, through command channels, the fire power of the heavy mortar company, all heavy weapons under regimental control, and the supporting artillery.

When selecting a weapon to execute a counterfire mission the counterfire officer first considers capabilities: that is, the range, trajectory, type of available ammunition, ammunition supply, nature of the target, speed in getting on the target, and contemplated employment in the immediate future.

Usually the close supporting artillery is best suited for the counterfire role. Whenever artillery fires can be utilized without undue loss of time, a request for this fire should be made. From the viewpoint of the counterfire officer, the most expeditious channel for requesting artillery is through the countermortar liaison officer. (The countermortar liaison officer in the present Table of Organization is the liaison captain in the battalion headquarters of each direct support artillery battalion; usually he is located at the infantry regimental command post.)

The 4.2-inch mortar is the most suitable *infantry* counterfire weapon. It is usually emplaced further from the front line than the 81-mm mortar and is more difficult for the enemy to locate. It fires a larger projectile at a greater range. Its ammunition resupply is more effective, as it rarely requires hand carry.

CONCLUSION

Regimental counterfire operations are actually a combined intelligence and operations function: intelligence because it is concerned with collecting, recording, evaluating, and interpreting combat information; operations because it coordinates the activities of those units who are able to take appropriate action.

The regimental counterfire officer is also the counterfire platoon leader. The GR-6 Sound Locating Set with which the platoon is equipped is the only equipment organic to the regiment for collection of enemy target information.

However, the GR-6 is merely a supplementary means of lolating hostile weapons. All other information must be sent to the counterfire officer, who works in the regimental command post in close coordination with the S-2 and S-3.

The most prolific source of counterfire information available in the infantry is the shelling reports submitted by combat personnel. When the individual soldier is trained to submit shelling reports accurately and quickly, the effectiveness of our supporting weapons will be increased.

Offensive Combat in Mountains

Mountain fighting usually resolves into a series of independent actions. The object of each of these actions is to seize and hold commanding ground. Infantry plays the dominant role because it is not road bound and it is more flexible than other arms. Infantry does forfeit some of its organic fire power in mountain fighting but this loss is offset by infantry shock action. With its portable weapons infantry can close with and destroy the enemy under almost any conditions of terrain.

The principles of offensive combat do not change in mountain combat. However, the manner of application of some of these principles is modified to conform to the special situation imposed by terrain and weather.

During combat in mountains the critical features are the mountain tops, the defiles, and the roads. Road nets frequently are very limited, and consequently, such roads as do exist have increased tactical importance. The roads are generally located in valleys or along defiles; however, the high ground must first be taken to gain control of the roads.

The basis of offensive combat in mountains is maneuver. Despite retarded mobility, infantry can still outflank the defender and strike him from an unexpected direction. Such maneuvers will undoubtedly entail some loss of command control. Even though forces are dispersed initially, the tactical plan always provides for regaining control on the objectives.

Security in mountain combat is an ever present problem. Long columns moving along a single route of advance give the enemy an opportunity to strike the flank of the advancing force. Ambushes can be prepared in defiles with

relative ease. To offset the defender's advantage in this respect, the attacker sends patrols to the high ground to secure the advance of his main body.

When attacking the enemy, frontal attack is avoided whenever possible. The enemy usually has superior observation and except when blinded by smoke or darkness he retains this advantage until the attacking troops actually close with the defending force. Attacks are planned to utilize all available defilade. However, the route of approach to the enemy position must not be so difficult that the attacking force will be completely exhausted on arrival. Exceptionally wide envelopments are avoided because lengthy maneuvers in mountain terrain exhaust the troops before they are able to close with the enemy. Envelopment of successive defended positions is usually a workable solution.

Employment of reserves is also subject to restrictions that do not prevail in less rugged areas. Usually they can not be moved rapidly from one point to another, and consequently the time required for employment of reserves is greatly increased. For this reason they are held as close as practicable to points at which they may be needed.

All supporting arms can accomplish their normal missions in mountain combat, but with some restrictions. Armor loses much of its mobility. Tanks can sometimes be used in small numbers against limited objectives, but their action is often limited to providing direct fire support. Artillery is effective; however, survey and fire control are more difficult, and extra time must be allowed the artillery for displacement. Engineers are indispensible and usually a substantial number of engineers is attached to or placed in support of an infantry unit. Their primary mission is to open supply routes and to remove obstacles.

Combat aviation is used to disrupt the defender's line of communication. Reconnaissance aviation performs its normal role; its use is frequently restricted, however, by weather conditions. When necessary, cargo aircraft are used to supply attacking forces by air drop.

The operation illustrated by the tactical exercise on the

following pages takes place in mountainous terrain. Each of the requirements facing the various commanders involved can be solved by common sense application of the principles of offensive combat.

GENERAL SITUATION

a. An enemy force estimated to be an infantry regiment, a battalion of field artillery, and a company of engineers, has been withdrawing north toward the town of BAKER, fighting repeated delaying actions against our advance from the south. Air reconnassance reported enemy foot elements moving southeast toward the town of ABLE from the vicinity of CHARLIE at 1800, 1 May. Small groups of enemy were also observed moving northwest from the town of EASY along ROUTE 2. (See Map 1.)

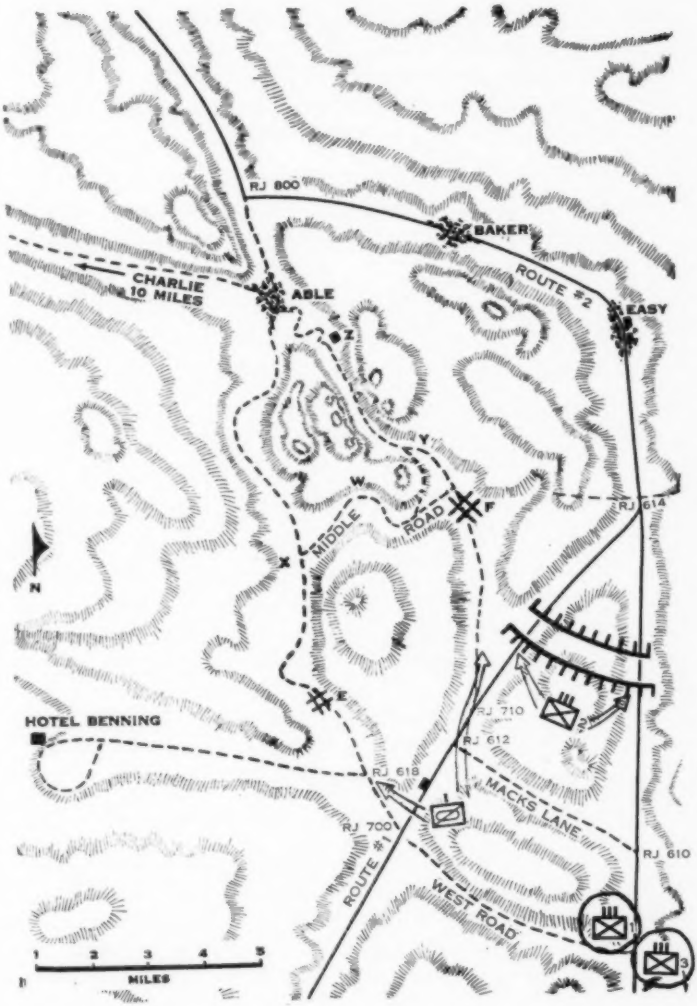
b. The 1st Infantry Division has been advancing northward along ROUTE 2 in a column of regiments. At 2000, 1 May the 2d Infantry Regiment, the leading element of the 1st Division, is in contact with the hostile forces north of RJ 610. (See Map 1.) The 2d Infantry objective is BAKER. The 1st and 3d Infantry Regiments are located in bivouac areas as shown on Map 1.

c. Daylight begins at 0500 hours, darkness at 1830 hours.

FIRST SITUATION

The 1st Infantry Regiment, reinforced, moved into bivouac in its present location at 1900, 1 May. At that time Colonel 1st Infantry received the following message from Major General 1st Division:

"The enemy is believed to be withdrawing to the northwest through BAKER along ROUTE 2. The 2d Infantry is in contact with the enemy astride ROUTES 1 and 2 about 2½ miles south of RJ 614. The 1st Division Reconnaissance Company reports defended roadblocks at POINT E on the WEST ROAD and at POINT F on the EAST ROAD. The 1st Reconnaissance Company has also reconnoitered the road to HOTEL BENNING and reported no contact. 1st Infantry Regiment, reinforced, will advance


RJ 800
BAKER
CHARLIE
10 MILES
ABLE
ROUTE #2
EASY
Z
Y
W
MIDDLE
ROAD
F
RJ 614
N
X
E
HOTEL BENNING
RJ 710
RJ 612
RJ 618
MACKS LANE
RJ 7001
ROUTE #1
RJ 610
WEST ROAD
1 2 3 4 5
MILES

Map 1.

northward early 2 May, seize the high ground north of ABLE, and establish a roadblock at RJ 800 to block enemy movement along ROUTE 2. Leading elements cross ROUTE 1 by daylight tomorrow. The following attachments to the 1st Infantry are effective immediately:

1st Field Artillery Battalion
Company A, 1st Engineer Combat Battalion
Battery A, 1st Antiaircraft Artillery Automatic Weapons Battalion
1st Platoon, 1st Ambulance Company
1st Platoon, 1st Clearing Company
2 liaison planes from division air section

TERRAIN ANALYSIS

Shortly after receiving the foregoing instructions from Major General 1st Division, Colonel 1st Infantry was given a brief terrain analysis of this area:

"The mountains in this area range from 3,000 to 5,000 feet and are generally covered with pine trees and some undergrowth. Good fields of fire can be obtained on the crests and along the ridges. The valleys and the terrain along the stream beds contain considerable vegetation; consequently, observation and fields of fire are relatively poor.

Vehicles are restricted to roads. Trails may be used for ¼-ton trucks but only after some engineer work.

WEST ROAD is passable to one-way traffic for all types of vehicles as far north as ABLE. Several roadblocks or small land slides have been located on this road by liaison aircraft. EAST ROAD is passable to one-way traffic for all types of vehicles as far as POINT Y. North of POINT Y light vehicles can be used to HOUSE Z. North of HOUSE Z there is a trail to ABLE which may be used by ¼-ton trucks only after considerable engineer work. MIDDLE ROAD is considered passable for all types of vehicles. The banks are steep on both sides of these three roads."

FIRST REQUIREMENT

You are Colonel 1st Infantry.

1. Will you select the WEST ROAD, the EAST ROAD, or both these roads for your route of advance?

2. What march objectives, if any, will you designate for the elements of your command advancing along the route(s) selected? What other means of control will you use?

3. How will you organize your reinforced regiment for the advance and what attachments will you make to each battalion?

4. What missions will you assign to the following:

a. 1st Battalion

b. 2d Battalion

c. 3d Battalion

d. 1st Field Artillery Battalion

e. 1st Platoon, Antiaircraft Artillery Automatic Weapons Battalion

f. Tank Company, 1st Infantry

g. Heavy Mortar Company, 1st Infantry

h. Company A, 1st Engineer Combat Battalion

i. Liaison Aircraft

A solution. 1. Colonel 1st Infantry decided to use both the WEST ROAD and the EAST ROAD.

2. Colonel 1st Infantry selected the following march objectives:

WEST ROAD COLUMN—POINT Y
HOUSE Z
ABLE

EAST ROAD COLUMN—RJ 618
POINT X
ABLE

Other means used to assist in controlling the column are radio, messengers, liaison planes, and foot and motor patrols.

3. Colonel 1st Infantry organizes his force as follows:

a. WEST ROAD COLUMN

(1) 1st Battalion

Attached: 1st Platoon, Regimental Tank Company.
Heavy Mortar Company, less 1st Platoon.
1st Platoon, Battery A, 1st Antiaircraft Automatic Weapons Battalion, less 2 sections.

(2) Company A, 1st Engineer Combat Battalion, less 1st Platoon.

(3) 3d Battalion

Attached: Regimental Tank Company less 1st and 2d Platoons.

(5) 1st Platoon, 1st Clearing Company

(4) 1st Platoon, 1st Ambulance Company (-)

b. EAST ROAD COLUMN

(2) 2d Battalion

Attached: 2d Platoon, Regimental Tank Company.
1st Platoon, Heavy Mortar Company.
2 sections, 1st Platoon, Battery A, 1st Antiaircraft Automatic Weapons Battalion.
1st Platoon, Company A, 1st Engineer Combat Battalion.
Intelligence and Reconnaissance Platoon.
Medical Detachment.

4. Colonel 1st Infantry assigned the following missions to elements of his command:

a. 1st Battalion, reinforced; advance at 0300, 2 May along the WEST ROAD: cross ROUTE 1 at 0500; drive the enemy to the north, seize the high ground north of ABLE in conjunction with the 2d Battalion; and prepare to establish a roadblock in the vicinity of RJ 800 to prevent enemy movement along ROUTE 2.

b. 2d Battalion, reinforced; advance at 0230, 2 May along ROUTE 2—MACKS LANE to ROUTE 1—ROUTE 1 to RJ 710—EAST ROAD: advance from RJ 710 at 0500; drive the enemy to the north; seize the high ground north of ABLE in conjunction with 1st Battalion; and prepare

to establish a roadblock in the vicinity of RJ 800 to prevent enemy movement along ROUTE 2.

c. 3d Battalion, reinforced: initially occupy an assembly area north of CR 700 as regimental reserve; be prepared to follow 1st or 2d Battalion on order.

d. 1st Field Artillery Battalion: support the advance of both columns; initial firing positions in the vicinity of RJ 612.

e. Battery A, 1st Antiaircraft Artillery Automatic Weapons Battalion, less 1st Platoon: attached to the 1st Field Artillery Battalion. 1st Platoon less 2d section, attached to 1st Battalion. 2d section, 1st Platoon, attached to 2d Battalion.

f. Regimental Tank Company, 1st Infantry, less 1st and 2d Platoon: attached to 3d Battalion. 1st Platoon, attached to 1st Battalion; 2d Platoon, attached to 2d Battalion.

g. Heavy Mortar Company, less 2d Platoon: attached to 1st Battalion. 2d Platoon attached to 2d Battalion.

h. Company A, 1st Engineer Combat Battalion less 2d Platoon: support the advance of the WEST ROAD COLUMN. 2d Platoon, attached to 2d Battalion.

i. Liaison planes begin reconnaissance of both routes of advance at daylight.

Discussion of solution. Offensive operations in mountains are characterized by decentralization of command. Colonel 1st Infantry realized that by utilizing both the WEST and EAST ROADS he would increase the possibility of finding a weakly defended route to the objective. Also he can employ a broader formation and therefore can use a greater number of troops by using both routes. Canalizing his troops on one route would reduce flexibility.

Because of the relatively high degree of decentralization which is often necessary in mountainous terrain a commander must use every means available to control the operations of the elements of his command. The use of march objectives is one method of coordinating the movement of his unit. Therefore, when there are well recognizable terrain features suitably located along the selected routes of

advance, is is advisable to designate these terrain features as march objectives.

Radios, messengers, liaison planes, and foot and motor patrols are used whenever conditions permit. In this manner the commander retains much of the control that would ordinarily be lost because of the difficult terrain.

The WEST ROAD, although a bit longer than the EAST ROAD, is the better of the two routes. Consequently Colonel 1st Infantry decided to move the bulk of his force along this route.

Because of the semi-independent nature of their missions, both the WEST ROAD COLUMN and the EAST ROAD COLUMN are well balanced forces. The 1st and 2d Battalions have been given adequate strength to accomplish their missions. Each has a tank platoon attached. Even though restricted to the roads much of the time, the tanks can still provide valuable direct fire support and thus add considerably to the striking power of the assault units. Although tanks cannot be used on EAST ROAD north of POINT Y they will be able to assist the 2d Battalion in advancing as far as that point and perhaps a little further, if firing positions are available. Although the use of tanks is restricted in mountain operations, every effort is made to make full use of them, even when they can be employed only in small numbers.

Heavy mortar fires should be immediately available; this need can best be met by including some heavy mortars with each column. These weapons are extremely valuable in mountain fighting. The bulk of the heavy mortar company (company less one platoon) moves with the larger force on WEST ROAD and is attached to the 1st Battalion. North of POINT X this portion of the company will be able to fire in support of both columns and therefore will probably revert to regimental control. The platoon with the EAST ROAD COLUMN may remain attached to the 2d Battalion if it proves too difficult for the heavy mortar company commander to regain control of that platoon. Any solution which insures heavy mortar support to both columns is

acceptable. If conditions existed that permitted giving heavy mortar support under regimental control, this method of tactical employment would be preferable.

Condition of the roads indicates that both columns need engineer support. The bulk of the engineers are placed in support of the larger force on the WEST ROAD and are well forward in the column where they will be readily available. The semi-independent operation of the EAST ROAD COLUMN dictates the attachment of one platoon to the 2d Battalion. In the past war outstanding engineer support made mountain fighting much easier for our forces. (Plans should also be made to use the Battalion Pioneer and Ammunition Platoons.)

4. *a, b, c,*—The missions assigned to the three battalions are general in nature. Details of the movement from the assembly area are worked out by battalion commanders. Attachments to the battalions join shortly after the regimental commander issues his order, or specific arrangements are made for the attached elements to join prior to the time the battalions move from the assembly area.

The regimental commander assigns specific routes in order to prevent confusion in the movement from the assembly area. For the same reason he indicates the time for each leading battalion to move out. Troops were not rushed to forward locations early in the evening since the distances to CR 700 and RJ 710 are relatively short. It was already dark when the regimental commander received his order and the troops were already getting settled for the night. Consequently, the regimental commander moves his columns at the latest hours which will enable them to cross ROUTE 1 by daylight. In mountain warfare good physical condition is a great asset, and commanders must be constantly alert to avoid causing unnecessary fatigue.

a. Since WEST ROAD and EAST ROAD are already crowded with traffic it is desirable to hold the artillery initially in firing positions that facilitate the supply of ammunition. Moving behind the 2d Battalion to the vicinity of RJ 612 the artillery will be prepared to support either

column shortly after daylight. The location selected also places the battalion in the most forward positions available; it will displace forward by echelon, to insure continuous artillery support. Since it is apparent that the columns will engage the enemy holding the roadblocks at E and F, the artillery will make registrations immediately after daylight. If the 1st Division Reconnaissance Company reports enemy activity closer to ROUTE 2 than the roadblocks, the artillery can register during the last hours of darkness; this is a slow and tedious process but it can be accomplished.

e. Since both of the two routes of advance have the characteristics of a defile, each column is assigned antiaircraft protection. The attached antiaircraft weapons, along with the organic antiaircraft weapons of the leading battalions and the attached tanks, provide active antiaircraft protection. In the absence of enemy aircraft these weapons provide excellent ground support. The bulk of the antiaircraft unit is used to protect the artillery.

f, g, h. Employment of the Regimental Tank Company, Heavy Mortar Company, and Engineer Company has already been discussed in paragraph 3.

i. Liaison aircraft are extremely valuable for reconnoitering a route of advance in mountains. They are capable of locating enemy roadblocks and mortar and artillery positions, and of adjusting the fires of our own artillery and mortars.

SECOND SITUATION

Lieutenant Colonel 2d Battalion received the order from Colonel 1st Infantry and immediately began work on his plan for the accomplishment of the mission.

1. He decided to use the following march order for his battalion, reinforced.

Company E, reinforced
Company F
1st Section, 1st Platoon, Battery A, 1st Antiaircraft Automatic Weapons Battalion
Company H (-)

Headquarters Company (-)
Company G, less one platoon
1st Platoon, Company A, 1st Engineer Combat Battalion
2d Section, 1st Platoon, Battery A, 1st Antiaircraft Automatic Weapons Battalion
1st Platoon, Heavy Mortar Company
One platoon, Company G (rear guard)

2. Lieutenant Colonel 2d Battalion issued the following instructions:

a. Company E:

Attached: One Section, Machine Gun Platoon, Company H
One Section, 81-mm Mortar Platoon, Company H
One Section, 75-mm Rifle Platoon, Company H
One Platoon, Regimental Tank Company

Constitute the advance guard for the battalion. Move north on EAST ROAD; destroy all enemy encountered. Report arrival at POINT Y and HOUSE Z. Be prepared to attack ABLE.

b. Company F: follow Company E. Be prepared to establish contact with elements of 1st Battalion by motor patrol on MIDDLE ROAD on battalion order.

c. Company H (-): follow Company F; support the advance of the battalion.

d. Headquarters Company (-): follow Company H (-).

e. Company G in reserve: follow Headquarters Company (-) and provide rear guard of one reinforced rifle platoon (transport to be provided to motorize this unit).

f. 1st Platoon, Company A, 1st Engineer Combat Battalion: march at the head of the motor elements and support the advance of the battalion.

g. 1st Platoon, Regimental Tank Company: attached to Company E.

h. 1st Platoon, Heavy Mortar Company: march with motor elements and support the advance of the battalion.

i. Intelligence and Reconnaissance Platoon: reconnoiter and screen the right flank.

SECOND REQUIREMENT

You are now Lieutenant Colonel 2d Battalion. Since your battalion is taking part in an offensive operation in the mountains, you should know the answers to the following questions:

1. The commander of a battalion attacking in mountain terrain will usually be able to maintain (choose one):

a. Closer control than when operating in average terrain.

b. Less control than when operating in average terrain.

c. The same degree of control as when operating in average terrain.

2. Attacking troops in mountains usually advance (choose one):

a. Along ridges.

b. Along valley bottoms.

c. Across valleys, from ridge to ridge.

3. In mountains listening posts have the greatest range of audibility when placed (choose one):

a. Near the top of a ridge.

b. In the valley bottoms.

c. On the lower part of the slopes.

4. The best method of controlling the direction of advance during an attack in mountains is to prescribe (choose one):

a. Boundaries between units.

b. Routes of advance and objectives for each unit.

c. A magnetic azimuth.

5. For communication, the commander of a unit attacking in mountains must rely chiefly on (choose one):

a. Radio.

b. Wire.

c. Messenger.

d. Visual Signals.

6. When attacking cross-country over mountainous terrain impassable to vehicles, it is best to (choose one):

a. Leave all crew-served weapons behind.

b. Hand carry all crew-served weapons and a limited amount of ammunition for each.

c. Reduce the number of crew-served weapons to be hand-carried in order to permit the carrying of more ammunition for each.

A Solution:

1—*b*
2—*a*
3—*a*
4—*b*
5—*a*
6—*c*

Discussion of solution. 1. The necessity for frequent decentralization of command has already been discussed. Not only does this condition arise during troop movements over restricted routes of communication, but it becomes aggravated upon contact with enemy forces. Decentralization is stressed in this exercise because it requires the highest degree of initiative and leadership.

2. Troops advancing in valleys are vulnerable to enemy fire from the dominating heights to front and flanks. Therefore, attacking troops advance along ridges to drive the enemy from the commanding ground. Where the enemy flanks are secure an advance across a valley requires a frontal attack against the ridge on the far side. Most reserves and larger supporting weapons can be brought into the valley only after the ridge is secured. Although often necessary, such advances are avoided when the objective can be reached by following a ridge.

3. Sounds carry plainly from valley bottoms to the hill tops. In the valley bottoms, sounds are muffled by ground forms and foliage and may be drowned out by flowing streams.

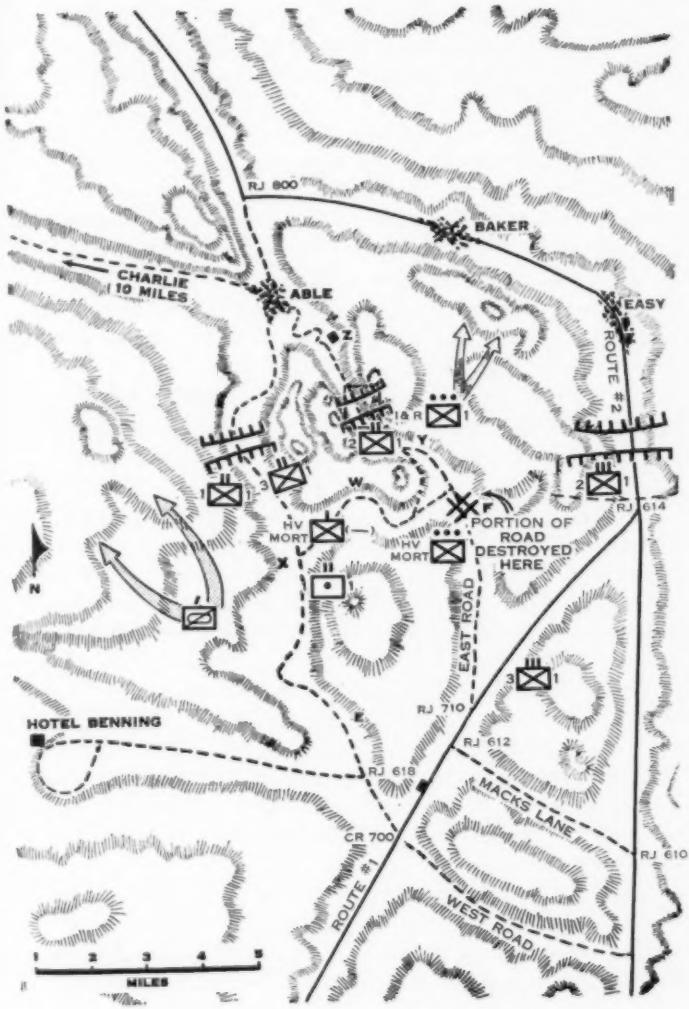
4. By prescribing routes and objectives, the commander knows where his units are located and he can intelligently and properly employ reserves and supporting fires. A series of prominent terrain features are selected as the objectives. Often the routes must be circuitous in order to obtain the best footing and to take advantage of opportunities for surprise and flanking action. Lateral contact between units may be impracticable because of rough terrain and wide separation of units; therefore, boundaries are of little importance. A prescribed direction of advance or azimuth is seldom used, because usually it is impossible to advance in a straight line.

5. Radios are quick and, in most cases, a dependable means of communication in mountain operations. The terrain often limits the use of radios but by establishing relay stations or by moving radio sets this limitation can usually be overcome. Wire is used as much as possible. Messengers are very slow and they often get lost. Visual signals are not always dependable and can often be seen by the enemy.

6. All infantry crew-served weapons can be hand-carried when the terrain does not permit the use of vehicles. However, the larger caliber weapons and their ammunition are heavy and bulky and can be carried over rough mountainous terrain only with extreme difficulty. Rather than use most of the available manpower to manhandle the heavier weapons, it is better to carry fewer weapons and more ammunition. There may be an opportunity to bring up the weapons left behind, together with additional ammunition, when a route for weapons carriers is opened, or when the situation becomes temporarily stabilized. Rather than forfeit the valuable support of crew-served weapons, however, infantry units carry some of them no matter how rough the terrain. Riflemen are often used to assist in carrying ammunition for crew-served weapons.

THIRD SITUATION

The remainder of this exercise deals specifically with a decision by Lieutenant Colonel 2d Battalion and with the tactical employment of a rifle company of his battalion.


RJ 800
BAKER
CHARLIE
10 MILES
ABLE
EASY
ROUTE #2
Z
Y
W
X
F
HV
MORT
HV
MORT
PORTION OF
ROAD
DESTROYED
HERE
RJ 614
EAST ROAD
RJ 710
RJ 612
HOTEL BENNING
RJ 618
MACKS LANE
CR 700
RJ 610
ROUTE #1
WEST ROAD
N
1 2 3 4 5
MILES

Map 2.

Map 2 shows the location of elements of the 1st Division at 1500, 3 May. A summary of preceding events follows:

The 2d Battalion moved across ROUTE 2 at RJ 710 at 0500, 2 May. Initial contact was made at the enemy roadblock at POINT F.

The roadblock was destroyed after a short fight and the enemy withdrew to the north along the EAST ROAD. During his withdrawal the enemy fired demolitions which damaged the road to such an extent that vehicles could not procede beyond POINT F. The engineers estimate that the road will not be open for traffic until 1900 hours, 3 May.

Following reduction of the roadblock at POINT F, Company E advanced against only scattered resistance for the remainder of that afternoon (2 May).

During the roadblock action the attached heavy mortar platoon moved into fire positions just south of the point where the road was damaged. Its location is shown on Map 2.

The battalion was halted on order from higher headquarters at march objective Y last night and resumed the advance at 0500, 3 May. A motor patrol located a land-slide across MIDDLE ROAD at POINT W but was able to bypass the obstacle on foot and establish contact with a patrol from the 1st Battalion.

The advance was resumed at 0500 this morning. Shortly thereafter enemy resistance increased to such an extent that the battalion was forced to deploy. The location of the elements of the battalion at 1500, 3 May and the known enemy situation in this locality at that hour are indicated on Map 3. (Map 3 is an enlargement of the area inclosed in a rectangle on Map 2.)

The specific situation at this time is as follows:

Company E is located in the vicinity of KNOB S. At 1430 it attacked north along the ridge line to seize KNOB R but was halted by:

1. Rifle fire from positions on KNOB R.

2. Machine-gun fire from an undisclosed position on KNOB R in the vicinity of POINT M.

3. Machine-gun fire from the log-covered emplacement at POINT N.

4. Machine-gun fire from several positions on HILL O.

5. Medium mortar fire from undisclosed locations in the vicinity of POINT P.

Map 3.

Company E has all of its organic weapons except one 57-mm rifle and one 60-mm mortar. It has 45 rounds (HE)

of 60-mm mortar ammunition and 25 rounds (HE) of 57-mm rifle ammunition. It has an adequate supply of small-arms ammunition.

The attached 81-mm mortars and 75-mm rifles have reverted to battalion control. The location of the 81-mm mortar section is indicated on Map 3. This section is now in general support of the battalion. There are 110 rounds (HE) and 20 rounds (WP) of 81-mm mortar ammunition at the firing position and approximately 200 HE and 30 WP rounds are due to arrive in two hours. The other 81-mm mortar section is still south of the roadblock. (POINT F, Map 2) The only 75-mm rifle forward at this time is located on HILL V with Company F. The machine-gun section, still attached to Company E, is carrying light machine guns. The heavy mortar platoon initially attached to the battalion is still located just south of POINT F (Map 2) and has an ample supply of ammunition. There is no change in the location and mission of the 1st Field Artillery Battalion. The tank platoon reverted to regimental control shortly after the roadblock at POINT F was reduced.

Company F on HILL V attacked earlier in the afternoon from its present location but after moving about 75 yards was halted by enemy mortars, rifles, and machine guns.

Company G in reserve is located at the position indicated on the map.

THIRD REQUIREMENT

You are Lieutenant Colonel 2d Battalion. The regimental commander has ordered you to seize KNOBS R and T by dark toninght (1830) and has informed you that you have priority of artillery fire until 1600. The time is now 1500. What is your general plan for accomplishing the mission?

A solution. Lieutenant Colonel 2d Battalion orders Company E to attack at 1530 and to seize KNOB R by 1700. The battalion commander gives priority of all supporting fires to Company E.

He orders Company F to initially support the attack of

Company E by fire from its present position and to be prepared to attack and capture KNOB T on order.

He orders Company G to move at once to the south slope of HILL S, occupy the position vacated by Company E, and be prepared to assist Company E.

Discussion of solution. In the present situation it is apparent that Lieutenant Colonel 2d Battalion is pressed for time; particularly so in view of the known enemy strength and the limitation on artillery support. He therefore makes a bold, aggressive, and positive decision. Since mountain fighting is characterized by a struggle for commanding ground, it is evident that the capture of KNOB R, the dominating terrain feature, is the key to the success of this attack.

From the standpoint of both terrain and location, Company E is in the best position to launch the attack. Lieutenant Colonel 2d Battalion must place time restrictions on Company E to meet the conditions stipulated by the regimental commander. In order to make maximum use of the artillery priority it would be advantageous to start without delay, but Lieutenant Colonel 2d Battalion knows that it is necessary to give Captain Company E some time to plan his attack. The half hour allowed strikes a medium. Two hours is about the maximum time that can be allotted to this phase of the battalion attack, since KNOB T also must be taken by dark.

It is better to have Company F "lean forward in their foxholes" and engage the enemy with fire rather than to have them attack simultaneously with Company E. Both KNOBS R and T are well defined so this is not a case of probing for a weak spot. The range from KNOB V (Company F's location) to KNOB R and T is not excessive and Company F can engage the enemy with a considerable volume of effective fire from its present location. Thus, Lieutenant Colonel 2d Battalion does not dissipate his supporting fires in support of two separate attacks, but concentrates all of the supporting weapons, first to assist Company E, later to assist Company F.

Lieutenant Colonel 2d Battalion moves Company G to where it can more readily assist the battalion's main attack. It would be a waste of manpower to place Company G in the assault since there is hardly enough room for Company E; to move Company G up the valley road would place this unit in a badly exposed position with the enemy occupying the commanding ground.

FOURTH SITUATION

Lieutenant Colonel 2d Battalion issued an attack order in conformance with his plan.

FOURTH REQUIREMENT

You are now Captain Company E. What is your general plan for the attack?

A solution. Company E to attack with one rifle platoon astride the ridge, one rifle platoon moving on the right of the ridge defiladed from the position on HILL O and the western slopes of KNOB R, and the third rifle platoon moving on the left of the ridge defiladed from the enemy machine-gun position at POINT N, and the enemy position on KNOB T.

The two 60-mm mortars, in general support of the Company, to fire on suitable targets of opportunity during the attack. One 57-mm rifle squad is attached to the center rifle platoon on the ridge; the other 57-mm rifle squad, in general support of the company initially to destroy the log-covered machine-gun emplacement at POINT N.

The artillery to fire HE on HILL O from H-5 to H-hour. After H-hour artillery to smoke HILL O to deny enemy observation. Artillery to fire HE concentration on KNOB R at 1530 and continue until the company is ready to assault the enemy position. Thereafter be prepared to fire on any suitable target on call.

Heavy mortars fire HE concentration on KNOB T at H-hour; thereafter be prepared to repeat this concentration of fire on any suitable target on call, particularly the suspected enemy mortar location.

The 81-mm mortar section (shown on Map 3) to be prepared to place harassing fire on any target not covered by other weapons or any surprise target on call.

The liaison plane to locate the enemy mortar position and other hostile targets.

Discussion of solution. Captain Company E's plan of maneuver cannot be complicated or time consuming. An effort to make a *wide* envelopment is ruled out by the time limit imposed. Every effort must be made to close with the enemy at the earliest time possible. To accomplish the mission under these conditions, Captain Company E selects the ridge line as the avenue of approach. Placing one rifle platoon on the ridge and another on the right of the ridge permits a close-in envelopment of either flank of the enemy position on KNOB R. From a map study of the terrain, it appears to be comparatively easy going on the left but extremely steep on the right; yet there is no indication as to which route will lead to the most success. Enemy weapons and the effectiveness of our fire also have a bearing on this particular point. Captain Company E prepares to place all three rifle platoons in the fight. The facts that he is assigned a limited objective, that Company G is closely available to back him up, and that he has excellent knowledge of the enemy defense, make his decision to use three platoons tactically sound.

The limited supply of ammunition for the 60-mm mortars precludes their use except for targets that cannot be neutralized or destroyed by weapons whose ammunition supply is not so critical. The 57-mm squad in general support was given the mission of destroying the log-covered emplacement at POINT N because this located point target is ideally suited for this weapon. The steepness of the slope makes precision adjustment difficult for the artillery and mortars; also to use either on the enemy emplacement would unduly confine these powerful supporting weapons to a small target that can be destroyed by the 57-mm rifle squad with a few rounds.

The attachment of a 57-mm rifle squad to the rifle platoon moving on the ridge places in the hands of this platoon leader a powerful supporting weapon which will

materially assist him in rapidly disposing of local opposition to his advance and thus maintaining the momentum of the attack.

Captain Company E considered the area targets HILL O, KNOB R and KNOB T by planning either artillery or heavy mortar concentrations on them. HILL O was smoked to deny observation. In mountain fighting, if the enemy occupies high ground, friendly forces must either take that ground or deny the enemy its use. It is not feasible to continually harass this area with HE artillery fire. By using several artillery pieces to maintain a smoke screen and using the remainder of the artillery for more important missions such as firing on KNOB R, he makes the maximum use of this supporting arm.

If smoke were placed on KNOBS R and T it would not only obstruct the enemy's vision, but would also deny observation to friendly forces. Since the enemy can deliver some defensive fires under all conditions of visibility, we would be hindering ourselves more than the enemy.

Captain Company E did not plan to fire on the suspected enemy mortar location initially because there were known targets of greater importance. In any event, to fire such a mission by guesswork would probably result in a waste of ammunition. His sound decision was to have a liaison plane definitely locate the enemy mortar positions before having the heavy mortar platoon fire on them.

Weapons Emplacements

All soldiers seek protection for themselves and their weapon when halted. When the halt is expected to be brief, troops take advantage of the protection afforded by ditches, shell holes, or folds in the ground. Whenever the situation becomes stabilized temporarily, they dig intrenchments for their individual protection and emplacements for the protection of their weapons.

Intrenchments and weapon emplacements are located where a selected area can be covered by fire and, at the same time, where the troops are provided with the maximum concealment and protection from air and ground observation and fire.

The tools normally available for hasty fortification work are carried by individual soldiers. These are supplemented by additional tools carried by the Pioneer and Ammunition Platoon. (See Figure 1) Under special terrain conditions such as frozen ground or extremely rocky areas, engineers may be called upon to furnish air compressors, bulldozers, and explosive charges.

The ground is usually excavated by pick and shovel. The nature of the soil, the tools available, the condition and experience of the men, the presence of the enemy, the size of the excavation, and the weather conditions, all affect the rate of excavation. Because of the various factors involved, precise data cannot be determined. As a rough guide, it may be stated that in medium soil, using standard tools, a man can excavate between 20 and 30 cubic feet per hour. Figure 2 gives estimates of the number of man-hours required to build emplacements for machine guns, mortars, rocket launchers, and 57-mm and 75-mm rifles. Add 50 per cent to these figures for constructing overhead cover.

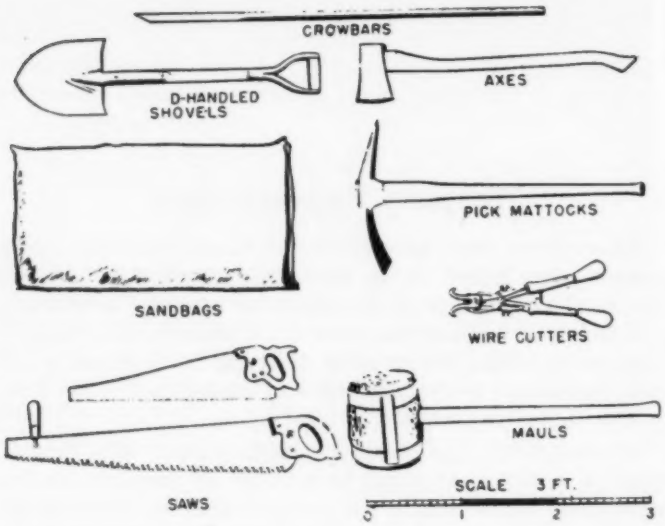


Figure 1. Principal tools carried in the infantry intrenching set.

EXCAVATION AND CAMOUFLAGE DATA FOR INFANTRY WEAPONS EMPLACEMENTS

WEAPON	TYPE OF EMPLACEMENT	AREA TO BE CAMOUFLAGED (FEET)	EXCAVATION (CUBIC FEET)	MAN-HOURS REQUIRED TO CONSTRUCT IN MEDIUM SOIL
Rifle	Foxhole	10x10	37	1½
Rocket Launcher	(Pit-Foxhole	10x10	(*25	1
	(Pit	5x5	(**87	4½
			50	3
Machine Gun, Heavy Cal .30	(Horse Shoe	15x18	140	8
	(3-Foxhole	15x15	111	5
81-mm Mortar	Pit	16x16	108	6
75-mm Rifle	Oval	20x15	200	7
57-mm Rifle	Oval	20x15	180	7

*Without Foxholes. **With Foxholes.

Figure 2. Excavation and camouflage data for infantry weapons emplacements.

Natural concealment is an important factor in locating defensive works. Before any excavation is started, all turf, sod, leaves, or forest humus is carefully removed from the area to be excavated. This material is placed over the spoil when the excavation is completed.

Drainage must be planned in the layout and construction of all emplacements. Surface and rain water can be excluded by deflecting it around the emplacement. Proper location limits but does not eliminate the drainage problem. If possible, low points and drainage lines are avoided, and emplacements are located on slopes. A slope of one per cent causes all water to run to the lowest part of an emplacement. Sumps located at one end of the emplacement are emptied by bailing, siphoning, or pumping.

Revetments or retaining walls are used to keep the emplacement walls from crumbling. When the position is to be occupied for more than a few days, revetments are necessary in all but the hardest ground. Decreasing the vertical slope of the wall accomplishes the same purpose, but it also decreases the protection afforded by the emplacement and makes concealment more difficult. Revetments require considerable labor and material, but they reduce maintenance and increase stability. Not only are earth walls in intrenchments and emplacements subject to normal erosion and the wear and tear of constant occupation, but they must also withstand the earth shock caused by explosion of bombs and artillery shells. (See Figure 3.)

Spoil from the excavation is used to form a parapet around the emplacement. The topsoil is used to camouflage the parapet, and turf, sod, leaves, or other litter from under nearby bushes or trees are added to make the parapet resemble its surroundings. If some of the spoil is not needed, it is either carefully hidden or it may be used to form a parpet for dummy positions.

Development of the proximity fuze which detonates a few yards above the target makes overhead cover for weapon emplacements of primary importance. The fragments from a shell armed with a proximity fuze are capable of producing a large number of casualties if the shell detonates over

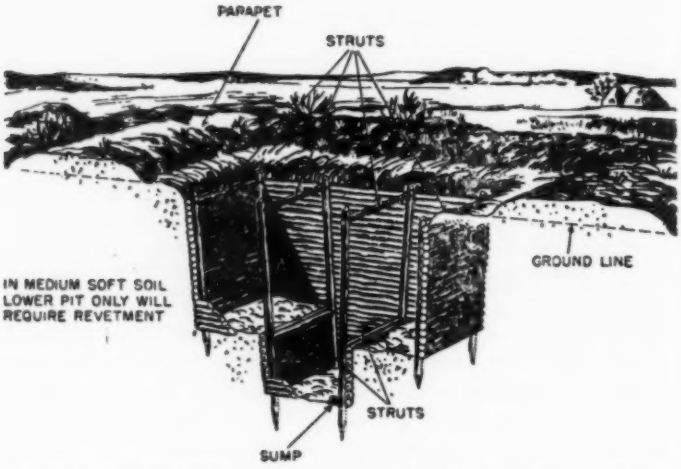


Figure 3. A cut-timber revetment is illustrated. Revetments may also be made of burlap and chicken wire or they can be constructed with brush.

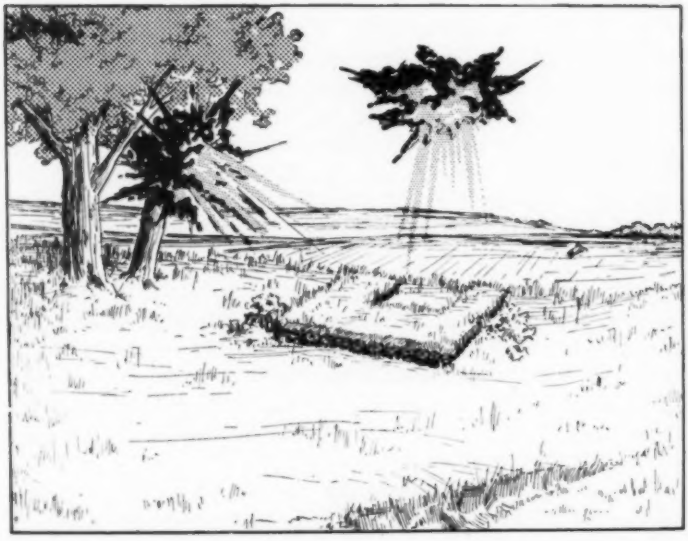


Figure 4. Overhead cover protects against tree or air bursts. The amount of protection afforded depends on the thickness and stability of the overhead cover.

an open emplacement. These fragments, however, are normally small and even an improvised cover will tend to protect the occupants. Covers made of timber, corrugated tin roofing, or other salvage from wrecked buildings, when covered with 2 or 3 inches of loose earth, will provide some protection. Although the fragments from air-burst shells will penetrate these covers, they are comparatively harmless after they have torn through the cover.

In a stabilized situation a permanent type cover is built for each emplacement. A cover made of timber at least 4 inches thick or sawed logs of equal width and covered with at least 1½ feet of loose earth will give some protection against artillery other than direct hits. For obvious reasons, this type of overhead cover is impractical for emplacements which are to be occupied only a few hours, or at most, one or two days.

When no material is available for constructing overhead cover, pack-boards with two or three field rolls fastened on the back and turned face downward over an open foxhole or horseshoe-type emplacement will provide a degree of protection against shell fragments. If no type of overhead cover is available, the occupants can tunnel into the sides of the emplacement. Areas must also be hollowed out for the weapon and ammunition.

A few of the standard type emplacements for infantry weapons are illustrated on the following pages. Recommended dimensions of these emplacements are based on experiences in World War II and on field tests.

MACHINE GUN EMPLACEMENTS

In the three-foxhole type emplacement, the tripod legs are reversed to permit the gun to be mounted close to the gunner's foxhole to facilitate firing. (See Figure 5.) The spoil is piled around the emplacement to form a parapet. Care is taken not to pile the spoil so high as to block the fire of the weapon. The gunner occupies the foxhole to the rear of the weapon; the assistant gunner occupies the foxhole to the left. The third foxhole remains unoccupied unless it becomes necessary to fire the gun to the left; in this

event, both the gunner and the assistant gunner shift to the right. When tanks are about to overrun the position, the gun is dismounted and the tripod is collapsed. One member of the crew takes the gun into his foxhole and the other member of the crew takes the tripod.

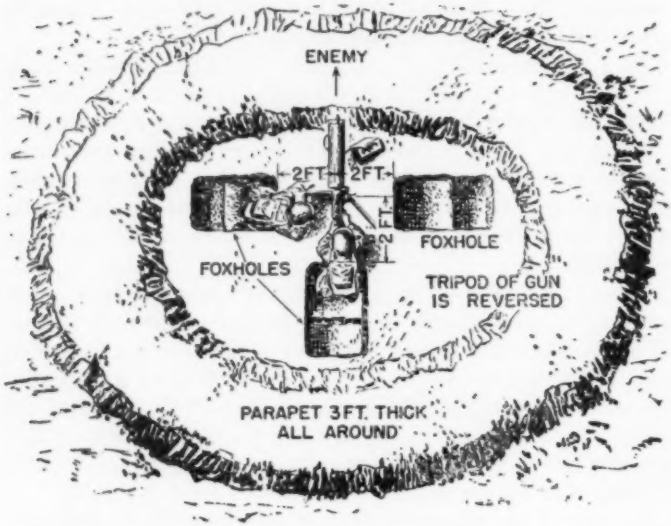


Figure 5. Three-foxhole type emplacement for caliber .30 machine guns.

A horseshoe emplacement can be developed from a shallow pit emplacement or it can be developed from the three-foxhole type emplacement (see Figure 6). In most types of soil, tanks can run over this emplacemnt without destroying it, the weapon, or the occupants. In loose soil, logs about 8 inches in diameter must be placed across the front, rear, and sides of the emplacement and embedded flush with the top of the ground to make it tank proof. Upon the approach of tanks the weapon is moved into the horseshoe trench and the crew crouch down on either side.

Overhead cover is usually added after the emplacement has been completed. It may be placed over the entire position, or pits may be dug into the sides of the position and

covered over. Where natural concealment is scarce, the overhead cover should be embedded flush with the ground surface.

In general, the horseshoe-type and the three-foxhole emplacement are both satisfactory for the heavy machine gun. The horseshoe-type emplacement is preferred for the light

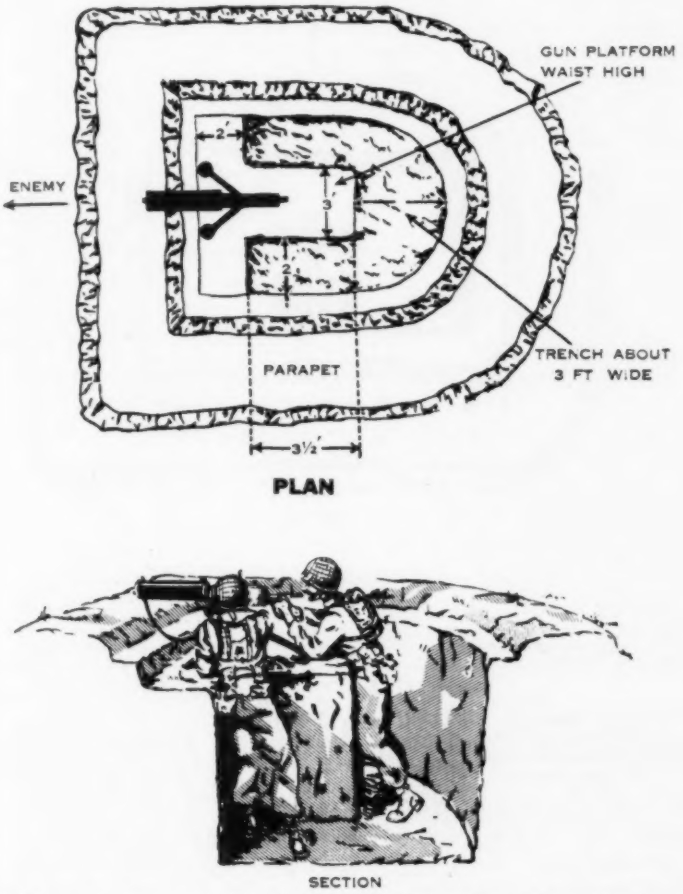


Figure 6. Horseshoe type emplacement for caliber .30 machine guns.

machine gun. As a firing position, the three-foxhole type is less flexible than the horseshoe type, but in some soil it is more tank proof. The three-foxhole type has the advantage of using standard foxholes. However, the horseshoe type permits the gun to be restored more quickly to its firing position following a tank attack, since the gun remains on the tripod.

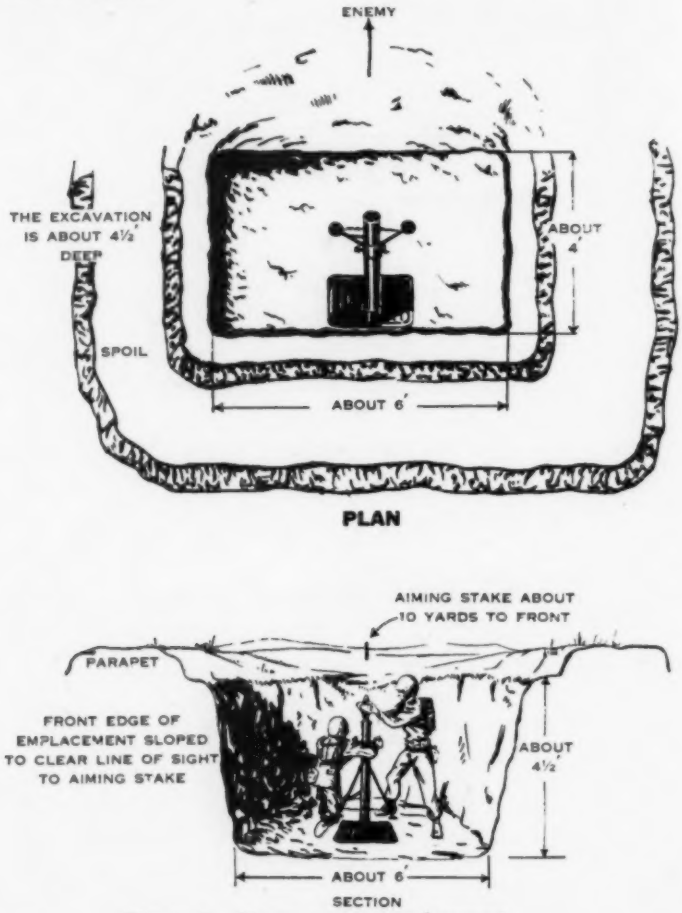


Figure 7. 81-mm mortar emplacement.

81-MM MORTAR EMPLACEMENT

Partial protection for the mortar and crew is achieved by digging a shallow pit about 4 feet by 6 feet by 2 feet and using the excavated earth to form a parapet. This pit is deepened to about 4½ feet, and the forward edge sloped. (See Figure 7.) This pit is large enough for the mortar, gunner, and assistant gunner. Foxholes for members of the squad not required at the mortar are dug near the emplacement. Additional ammunition is placed in nearby shelters.

As soon as possible an additional hole is dug on the back side of the initial pit. This hole is large enough to contain the mortar, gunner, and assistant gunner. This hole and about 1 foot of the original pit are then covered over with logs and earth. When possible the overhead cover is embedded flush with the ground.

57-MM RIFLE EMPLACEMENT

In the first stage two parallel shallow pits are dug 2 feet wide by 5½ feet long and 2 feet apart, and the spoil is used to form a parapet. The rifle is mounted on the platform between the pits. This provides some protection from small-arms fire and shell fragments.

The second stage is to convert the shallow pits into modified one-man foxholes 3½ feet to 4½ feet deep, 5½ feet long, and 2 feet apart. The rifle is mounted on the platform between the two foxholes. In some types of soil it will be necessary to revet the platform between the two foxholes. The parapet formed by the spoil must be kept low enough to permit firing in all directions. The backblast escapes over the parapet. This stage provides protection against small-arms and artillery fire and the crushing action of tanks. (See Figure 8)

The third stage is to complete the emplacement by providing overhead cover for the gunner and assistant gunner, and completing camouflage. The rifle is protected by placing it in either of the foxholes. Camouflage is provided by placing a low, level camouflage net over the entire position. The net should be provided with a quick opening embrasure over the rear portion of the emplacement to prevent damage to the net by the backblast.

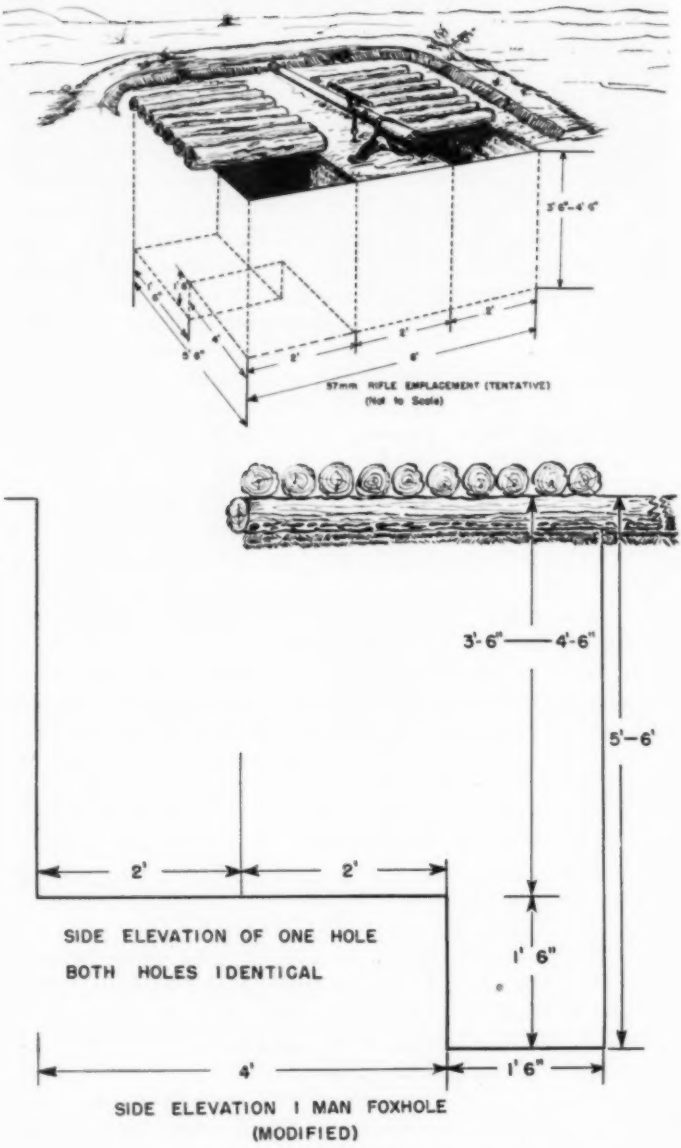


Figure 8. 57-mm rifle emplacement.

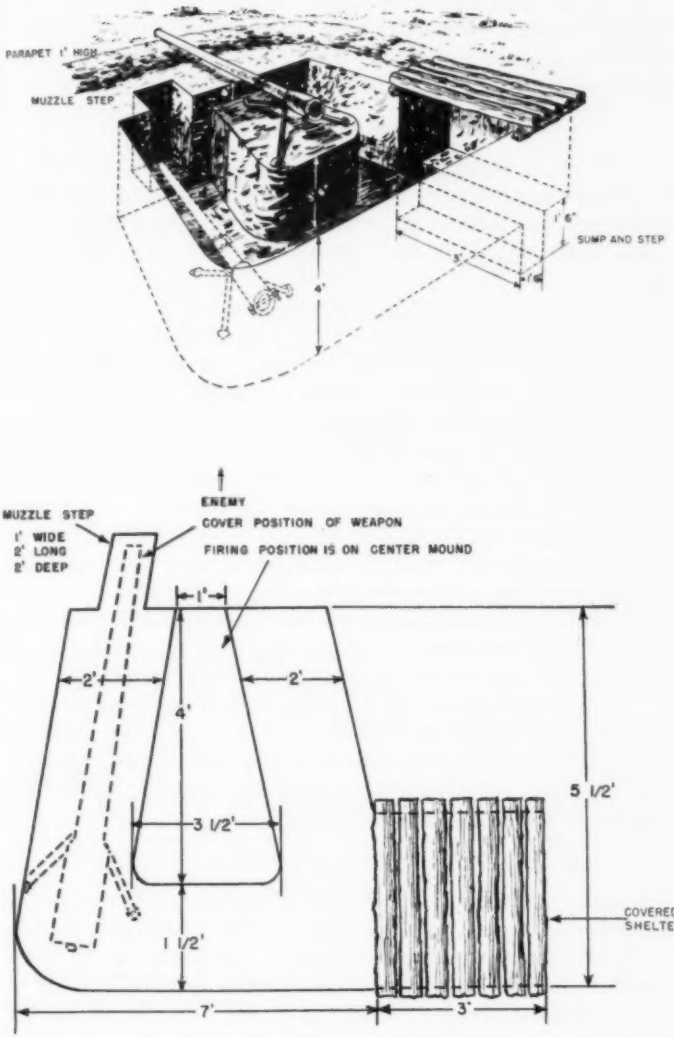


Figure 9. 75-mm rifle emplacement.

When the machine gun tripod M1917A1 is used as the mount for the 57-mm Rifle, the 75-mm Rifle Emplacement shown in Figure 9 may be used. The muzzle step is not necessary because of the shorter length of the 57-mm Rifle.

75-MM RIFLE EMPLACEMENT

In the first stage a 5½ by 7½-foot open shallow pit is dug conforming to the plan view of the finished emplacement, and the rifle is mounted in the pit. This stage provides some protection from small-arms fire and shell fragments.

The second stage is to dig a horseshoe shaped trench around a firing platform which supports the tripod. In some types of soil it will be necessary to revet the firing platform. The top of the platform is one-half foot below the surface of the ground and the spoil from the trench is used to build the parapet to a height of one foot above the ground level. These dimensions give the rifle sufficient height to allow the backblast to escape over the parapet. The horseshoe emplacement permits fire in all directions. This stage provides protection against small-arms and artillery fire and the crushing action of tanks. (See Figure 9.)

The third stage is to complete the horseshoe emplacement by providing overhead cover for the gunner and assistant gunner, and completing camouflage. The rifle can be protected by placing it in the trench. Camouflage may be provided by a low, level camouflage net over the entire position. The net should be provided with a quick opening embrasure over the rear portion of the emplacement, to prevent damage to the net by the backblast.

ROCKET LAUNCHER EMPLACEMENT

Initially this emplacement is a circular pit, 3 feet in diameter and about 3½ feet deep. It is large enough for two men, and it permits the assistant rocket gunner to move about so that he is never in rear of the weapon when it is fired. The rear end of the rocket launcher at maximum elevation must clear the parapet so that the backblast from the rockets is not deflected into the emplacement. Except in firm soil, this requirement is satisfied only by an

emplacement that is too shallow to provide protection against crushing action of tanks. Therefore, foxholes for the rocket gunner and his assistant are dug nearby. Because the antitank mission of this weapon requires it to be kept

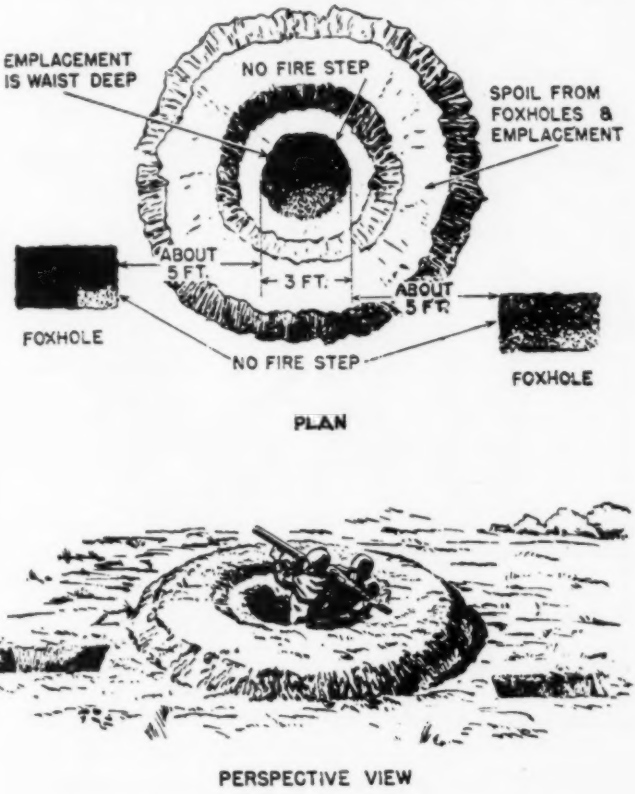


Figure 10. Emplacement for rocket launcher.

in action against hostile tanks until the last possible moment, these foxholes are occupied only when a tank is about to overrun the emplacement. (See Figure 10.)

In firm soil, the circular pit can be enlarged to 4 feet in diameter and an additional circular pit 2 feet deep and 2

Figure 11. Sectional view of rocket launcher emplacement.

feet in diameter can be excavated in the center. This results in a circular fire step 1 foot wide and about 2½ feet below ground level. When tanks are about to overrun the position, the rocket gunner and the assistant crouch down in the lower pit. When the tanks have passed, the rocket launcher is quickly returned to action. (See Figure 11.)

When heavy logs are available the pit emplacement is completed by digging two-man foxholes with overhead cover. This method is practical only when there is no danger of the overhead cover deflecting the backblast into

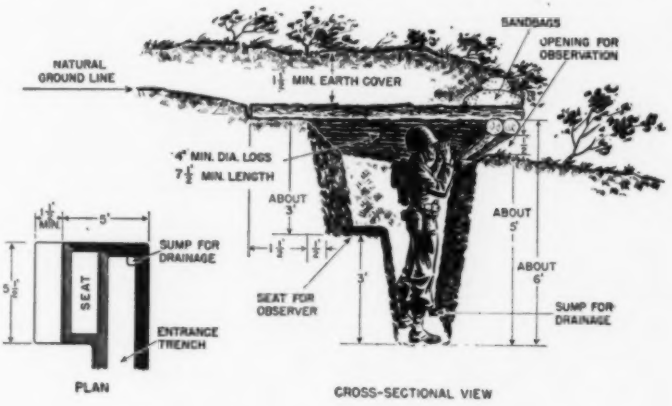


Figure 12. Covered observation post.

the firing pit. To prevent this it may be necessary to raise the fire step approximately one foot. An alternate method is to provide overhead cover for nearby foxholes.

OBSERVATION POSTS

Initially, a one or two-man foxhole makes a good observation post. Both of these position must be well camouflaged. Where positions are occupied for considerable time, however, it is desirable to construct a sturdier type observation post to afford greater protection. (See Figure 12.)